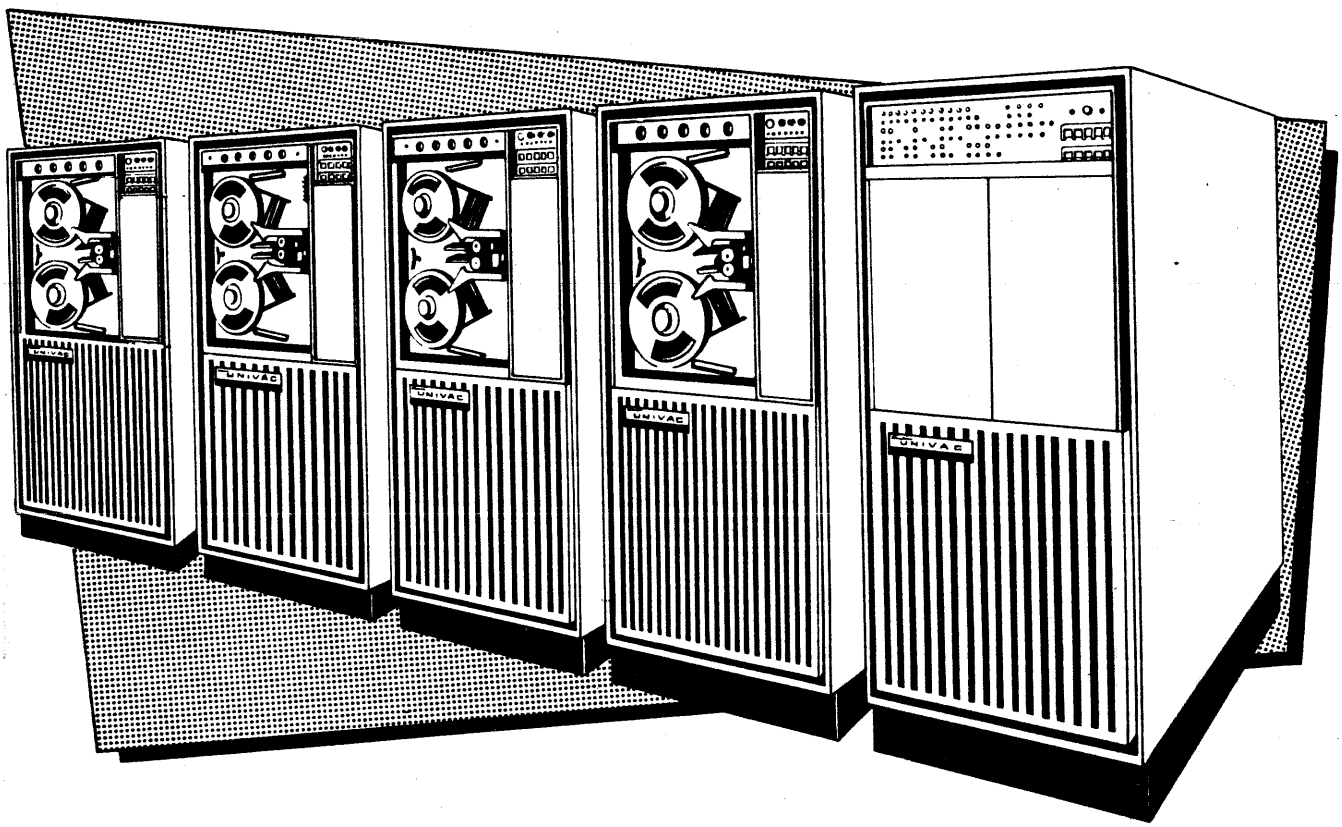
UNIVAC® FILE-COMPUTER DATA AUTOMATION SYSTEM



SORT-COLLATE SYSTEM

ANOTHER SERVICE OF

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Remington Rand Univac

DIVISION OF SPERRY RAND CORPORATION

P R E L I M I N A R Y M A N U A L

SORT-COLLATE

SYSTEM

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Remington Rand Univac
Division of Sperry Rand Corporation

PRELIMINARY MANUAL
SORT-COLLATE SYSTEM UFC

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Chapter I

INTRODUCTION TO THE SORT-COLLATE SYSTEM

SORT-COLLATE SYSTEM RESUME

The Sort-Collate System is composed of the sort-collate unit, which is a special-purpose tape processing device with a single type of input-output unit, and four magnetic tape input-output units. Although the sort-collate unit does not have inherent computing capabilities, it does have the housekeeping capabilities normally associated with computers, and under certain circumstances, can transfer control to the central computer which performs the required arithmetic operations. The sort-collate unit is illustrated in Figure 1.

The special-purpose function of the Sort-Collate System is the ordering of magnetic tape data which includes:

1. Sorting, or the actual rearranging of items of information in ascending sequence according to the key or identifier in each item,

2. Sequence checking, or the checking of the keys in each item in a file for ascending sequence,

3. Merging, or the combining of two or more ordered (sorted) files to produce a combined ordered file, and

4. Extracting, or the production of one or more selective files from a master file by means of selecting specific data which is larger than, equal to, or smaller than one key or selecting data which falls between the ranges of two separate keys.

For purposes of this manual, the sorting and sequence checking functions are referred to as sorting operations to distinguish them from the merging and extracting functions, which are referred to as collating operations.

The sorting operations are defined by an ascending sequence sort routine which is internally wired into the system, and is therefore fully automatic in operation. The collating operations are plugboard defined and provide means, under special conditions, for transferring control to the central computer. The plugboard program is a series of steps in the following format:

Step				
In	Out	PR	S	D
0	0	0	0	0

"Step In" initiates the collation program step, "PR" defines the basic process to be performed, "S" specifies the magnetic tape unit which contains the source data, "D" defines the destination tape unit or units, and "Step Out" controls the sequencing of the collation program.

The Sort-Collate System was designed primarily for use as an independent, off-line device in Univac File-Computer Model 1 Systems. The term "off-line" means that the Sort-Collate System is not connected to the central computer in any way, and is therefore completely independent of the computer.

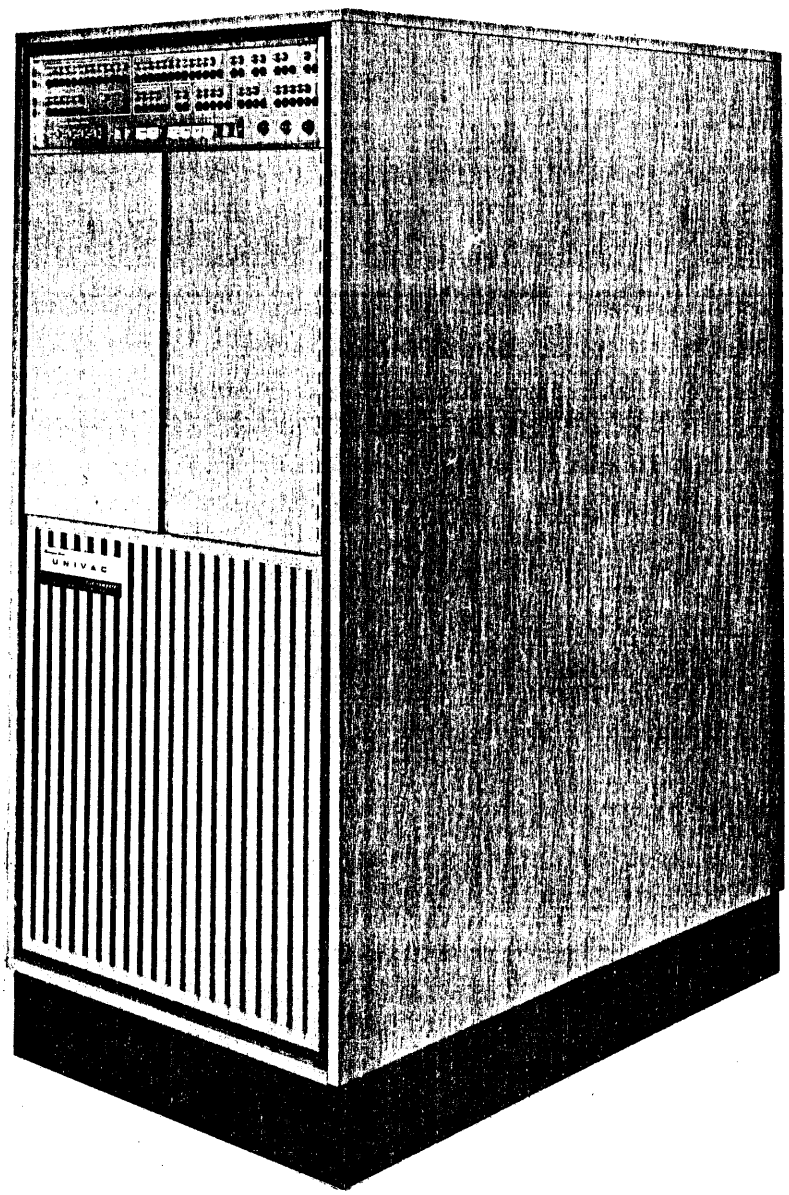


Figure 1. Sort-Collate Unit

The Sort-Collate System also has a pseudo "on-line" mode of operation (when physically connected to the computer) in which it is capable, in collation programs only (not sorting operations), of two-way communication with the central computer. In addition to off-line or on-line use with a Univac File-Computer Model 1 System, the Sort-Collate System can function as auxiliary off-line equipment for other data processing systems which have at least one magnetic tape handler that is tape compatible with the File-Computer tape units described in Chapter II (Input-Output Medium).

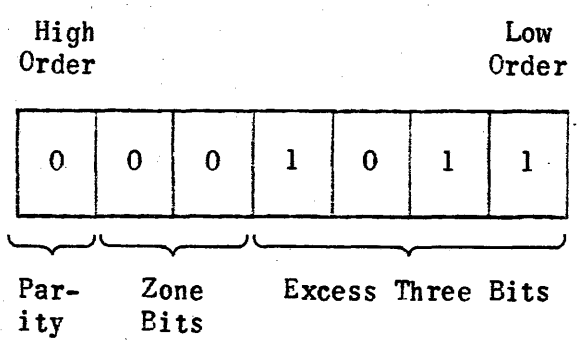
UNIVAC 7 LEVEL CODE

The sort-collate unit is a special-purpose tape processing device which orders or processes magnetic tape data according to the sequence of the Univac 7 Level Code which is illustrated below in Table 1.

ZONE	EXCESS THREE BITS															
BITS	0000	0001	0010	0011	0100	0101	0110	0111	1000	1001	1010	1011	1100	1101	1110	1111
00	i	Δ	—	0	1	2	3	4	5	6	7	8	9	'	&	(
01	r	,	.	;	A	B	C	D	E	F	G	H	I	#	¢	@
10	t	"	|	)	J	K	L	M	N	O	P	Q	R	$	*	?
11	Σ	β	:	+	/	S	T	U	V	W	X	Y	Z	%	=	not used*

Table 1. Univac 7 Level Code

The basic unit of information for the Univac File-Computer System is an alphanumeric character expressed in Univac 7 Level Code. Each character is 7 binary bits in length. For example, the computer character "8" expressed in Univac 7 Level Code would have the following format:



The high order parity bit is used principally for checking the accuracy of data transmission in the system. The "1's" bits must always add up to an odd number of bits. The low order 6 binary bits (the only bits shown in Table 1), represent

the actual alphabetical or numerical character expressed in excess three, binary coded decimal notation known as the Univac 7 Level Code. To obtain the parity bit, it is only necessary to count the 1's and produce an odd count, if necessary, by inserting a "1" as the parity bit.

For purposes of sorting or collating operations, the parity bit is disregarded, thus the zone bits are in the high order position. The smallest character in the sorting sequence is an ignore code or "i", and is designated as 1 00 0000. The largest valid character is the code for an equal sign or "=", and is designated as 0 11 1110. In the operation of the sort-collate unit, no two characters are treated as equal. For example, a zero and a space code are considered to be different characters. This is not the case in certain central computer operations.

MODES OF OPERATION

General

The Sort-Collate System can be operated in one of the three following modes of operation

1. As an independent, off-line device used in connection with a Univac File-Computer Model 1 System,

2. As an on-line device used with a Univac File-Computer Model 1 System, or

3. As an auxiliary off-line device used with other data processing systems, which have at least one magnetic tape handler, that is tape compatible with the units described in Chapter II (Input-Output Medium).

Regardless of the mode of operation, four tape units, designated as Magnetic Tape Unit I (MTU I), MTU II, MTU III and MTU IV are used with the sort-collate unit to form the Sort-Collate System.

The sort-collate unit has four sets of plugs labeled I, II, III and IV expressly written in Roman Numerals to differentiate the tape unit designations from the demand stations. Any one of the identical magnetic tape units can be connected by a technician into the set of plugs labeled I in the sort-collate unit, but once so plugged, this particular tape unit becomes MTU I to the Sort-Collate System, until such time as a technician is directed to substitute another tape unit so that it becomes MTU I. This is also true of MTU II, MTU III and MTU IV.

Independent, Off-Line Mode of Operation

The sort-collate unit, when used in a Univac File-Computer Model 1 System, as an independent, off-line device, operates completely apart from the computer. In this pattern the four tape units are plugged into the sort-collate unit as described above, no connections are made to the computer, and no demand stations are used. Figure 2. illustrates the Cabling Diagram for Independent Off-line Mode of Operation of the Sort-Collate System.

Three OPERATION MODE buttons, located on the sort-collate control panel, monitor the type of activity that can be carried out by the Sort-Collate System. The three buttons and their functions in the off-line mode of operation are:

1. DEMAND button which should not be used in the off-line mode of operation since no demand stations are used, and no operations can be performed if the DEMAND button is depressed,

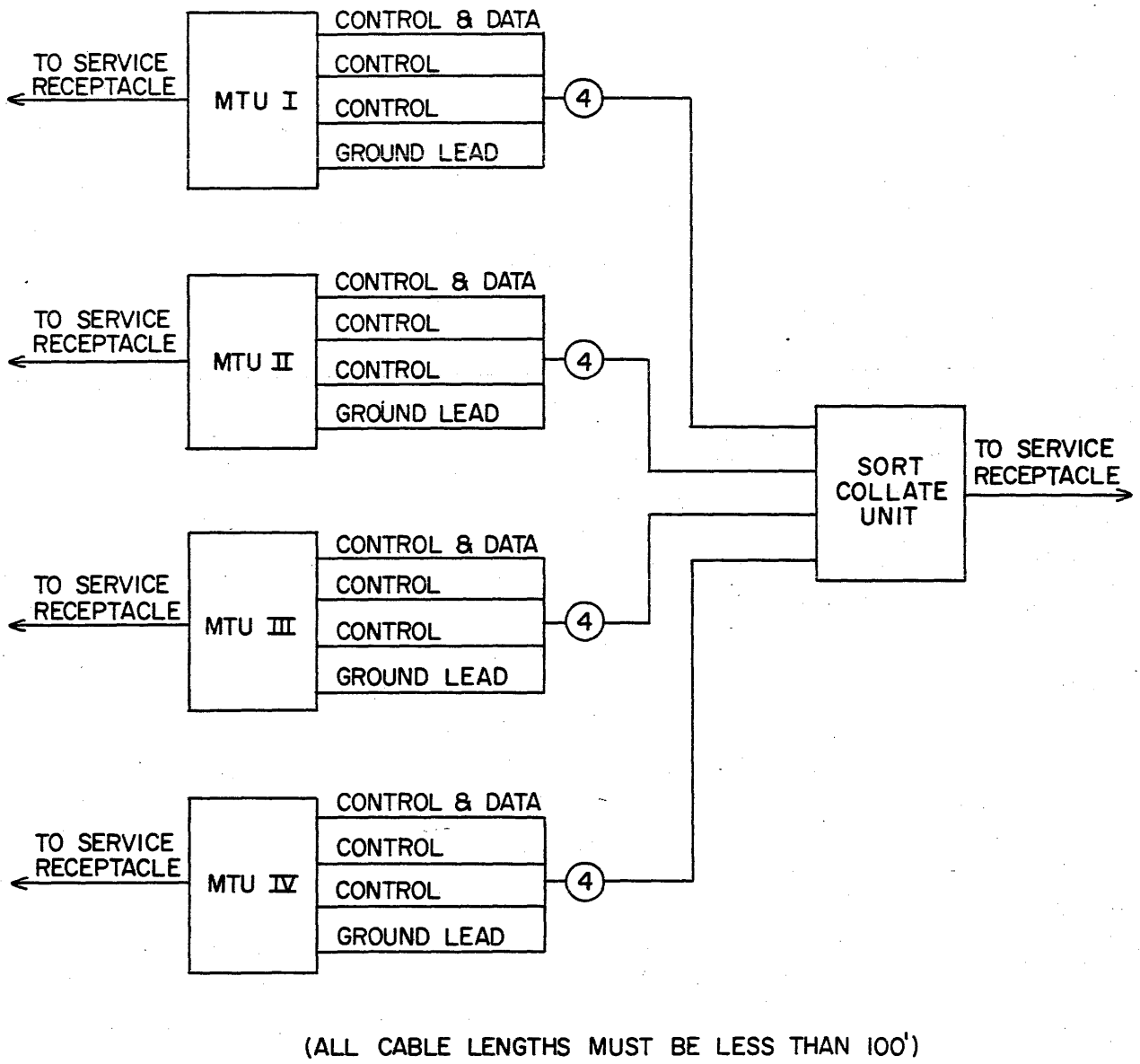


Figure 2. Cabling Diagram for Independent, Off-Line Mode of Operation of the Sort-Collate System

2. SORT button, which when depressed, allows only the automatic sort and sequence checking functions (in which the four tape units are controlled exclusively by the internally wired sort routine), to be performed, and the

3. PROGRAM COLLATE button, which when depressed, provides exclusive control of the four magnetic tape units by the plugboard defined program; however, no provision is made for communication with the central computer in the off-line mode of operation.

On-Line Mode of Operation

The Sort-Collate System, when used in an on-line mode of operation, is physically connected to the central computer. In this pattern the sort-collate unit shares control of the four tape units with the computer. Part of the cabling from the four tape unit demand stations is connected to the sort-collate unit, and the other part of the cabling, from each of the four tape unit demand stations, is connected to the computer.

Since the tape unit designation has no direct relation to any particular demand station, it is not necessary for MTU I to be connected to demand station 1. Any one of the 10 available demand stations in the central computer may be connected. This is also true for MTU II, MTU III and MTU IV. Figure 3 illustrates the Cabling Diagram for (psuedo) On-Line Mode of Operation of the Sort-Collate System.

As in the case of off-line mode of operation, the activity of the sort-collate unit is monitored by the choice of the OPERATION MODE button on the sort-collate control panel.

The three OPERATION MODE buttons operate in an on-line mode of operation as follows:

1. If the DEMAND button is depressed, the tape units are directly and exclusively controlled by the computer. The operation of the tape units is the same as if each were directly plugged into the computer as input-output units.

2. If the SORT button is depressed, each tape unit is exclusively controlled by the internally wired sort routine of the Sort-Collate System. All communicating circuits between the MTUs and the computer are disabled. If the computer program either test demands, or demands MTUs II, III, or IV computer operations cease, just as if no input-output unit were connected to that demand station. However, there are test lines from the sort-collate control unit to the demand station associated with MTU I. The sort-collate control monitors MTU I placing it in a NOT READY status, during the SORT mode, as far as the computer is concerned.

3. If the PROGRAM COLLATE button is depressed, each tape unit is, in general, controlled by a plugboard defined collation program. While

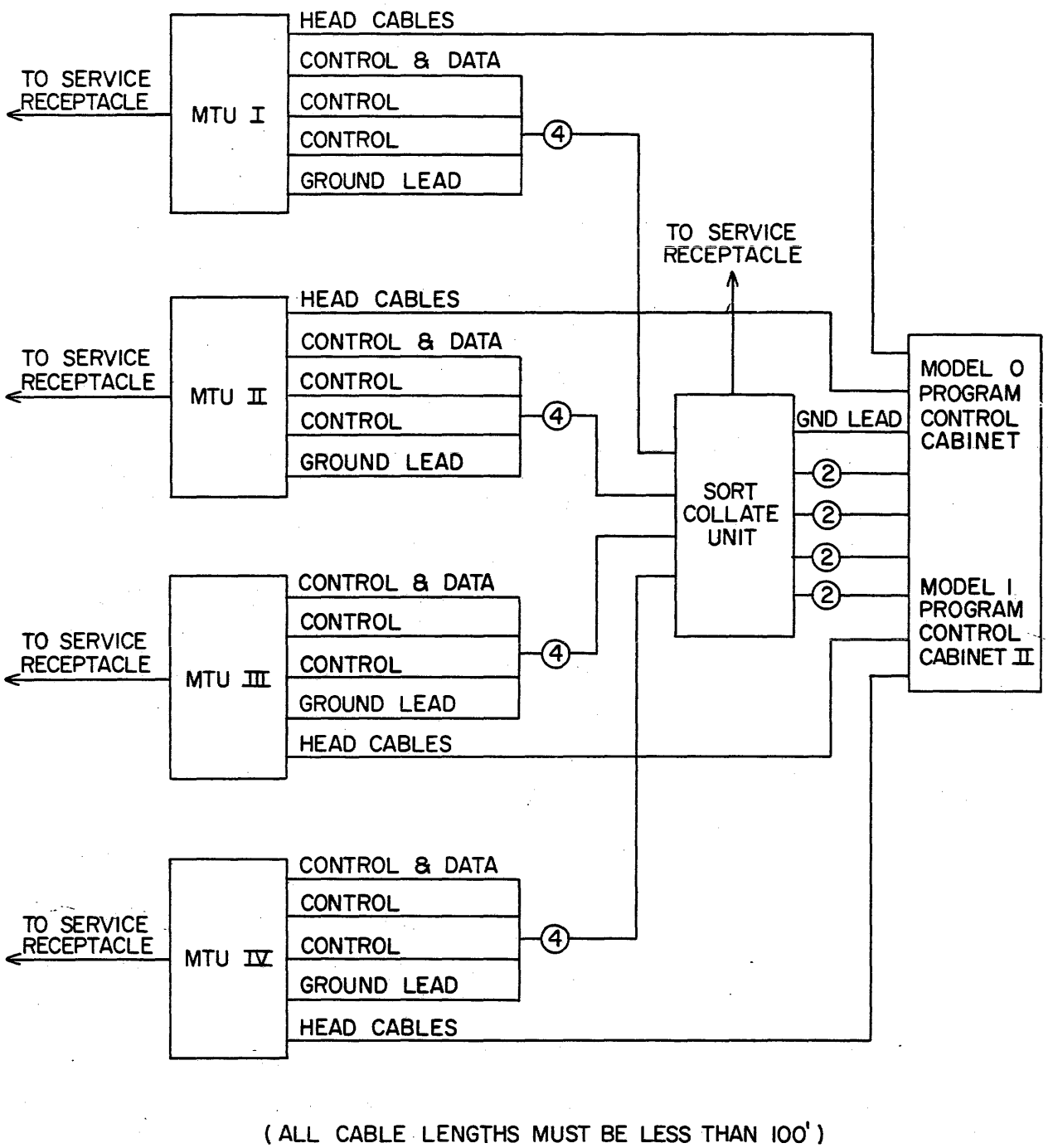


Figure 3. Cabling Diagram for (psuedo) On-Line Mode of Operation of the Sort-Collate System

the tape units are performing the plugboard-defined collation operations, the status of communication between the MTUs and the computer is the same as described in 2. above. However, as explained later under computer alert, if the collation program is so wired, the collating operations of the MTUs can be interrupted; the communicating circuit between the MTUs and the computer are connected; and control of the tape units is turned over to the computer. Each tape unit can thereafter function as an input-output unit for the computer. The purpose of the computer alert feature is to permit collating and file updating operations to be performed in a single pass through the tape data. Upon completion of its updating routine, the computer must be programmed to revert control of the tape units back to the Sort-Collate System. If the plugboard wiring defining the collation program so specifies, the collating operation continues automatically thereafter. Subsequent computer alert operations can be carried out if the collation program is so wired.

When the Sort-Collate System is used in an on-line mode of operation, four demand station positions are used by the tape units regardless of its activity. The sort-collate unit does not have a demand station position, but it does have certain circuitry very similar to that in a demand station. In computer alert operations, the Sort-Collate System utilizes the demand station of MTU I to notify the computer that computer alert has been initiated. The sort-collate's pseudo demand station then communicates with the computer to achieve the tape unit control exchanges.

The Sort-Collate System when used in an on-line mode of operation uses four of the ten available demand stations. It is possible to include two separate on-line Sort-Collate Systems with one Univac File-Computer Model 1 System, thus using eight demand stations. However, although a technician can disconnect the sort-collate unit from the central computer freeing four demand stations for use with other peripheral equipment, it is strongly recommended that this procedure should be avoided whenever possible, and the original connections to the demand stations in the central computer be left undisturbed.

Auxiliary Mode of Operation

The Sort-Collate System can be used as an auxiliary off-line device with other data processing systems which have at least one magnetic tape handler that is tape compatible with the units described in Chapter II (Input-Output Medium). This is essentially the same mode of operation as an independent off-line mode of operation. Please refer to the topic on Independent, Off-line Mode of Operation, in this chapter.

Unless specifically noted, it will be assumed throughout the remainder of this manual that the Sort-Collate System is used in an on-line mode of operation.

Chapter II

INPUT-OUTPUT MEDIUM

TAPE SPECIFICATIONS

Four Univac File-Computer Magnetic Tape Units and a sort-collate unit form the Sort-Collate System. A Magnetic Tape Unit is shown in Figure 4. Magnetic tape used on the Univac File-Computer Magnetic Tape Units must meet the following specifications:

1. Type of tape - Mylar magnetic tape.

2. Width of tape - 1/2 inch.

3. Base - 1 1/2 mill mylar.

4. Recording density - 139 lines per inch in blockette format.

5. Reading density - 50 lines per inch to 160 lines per inch on mylar magnetic tape.

6. Blockette spacing - 0.5 inches or 1.0 inches between blockettes.

7. Block spacing - 0.5 inches or 2.4 inches between blocks (every 6 blockettes).

   The blockette and block spacing is selected for output by means of a dual setting selector switch on the tape unit control panel. The settings are labeled UFC and Univac. If set to UFC (Univac File-Computer Mode), the tape unit does not differentiate between blockettes and blocks but merely produces 0.5 inches spacing between all blockettes. If set to Univac (Univac I and II Mode), the tape unit provides 1.0 inches between blocks. Either format is acceptable for input.

8. Blockette length - 120 character blockette recorded at a density of 139 lines per inch makes a blockette 0.86 inches in length.

9. Blockettes per reel as specified by the automatic blockette counter - 20,000 blockettes at 1/2 inch blockette spacing for use in Univac File-Computer Mode, 14,100 blockettes at 1 inch blockette spacing for use in Univac I and II Mode. Either of the blockette counter limits is chosen by means of the UFC-Univac dial selector on the tape unit control panel.

10. Absolute maximum number of blockettes per reel - 20,870 blockettes at 1/2 inch spacing 14,400 blockettes at 1 inch spacing.

11. Standard length reel - 2400 feet.

INPUT FORMAT

The magnetic tape input medium, in addition to meeting the physical requirements noted above, should be recorded in a specific format. General Tape Format, describes the points to be considered in using magnetic tape whether or not it is to be used as input for the Sort-Collate System. Sort-Collate Tape Format, describes the additional points to be considered when the magnetic tape is to be used as input for the Sort-Collate System.

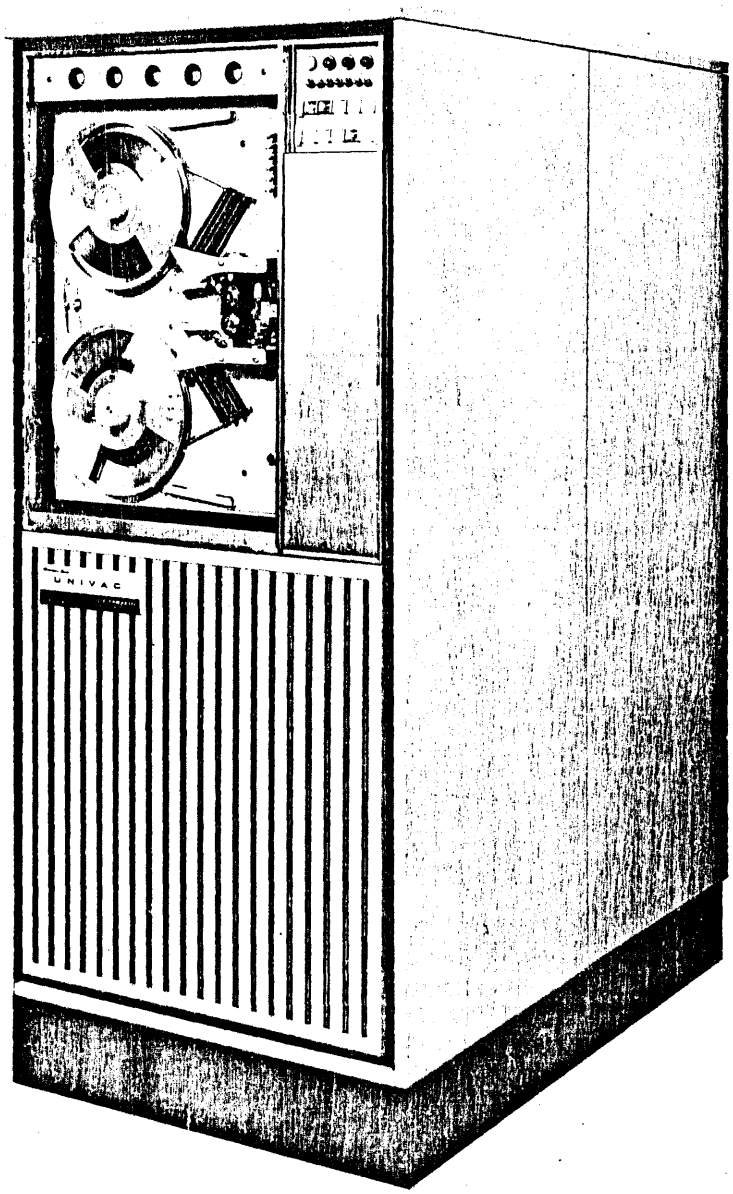


Figure 4. Univac File-Computer Magnetic Tape Unit

General Tape Format

The magnetic tape input data should be recorded in the following format:

1. The principle programming unit should be the file which is composed of a group of adjacent items, each item being a collection of consecutive characters uniquely defining a major file entry. The make-up of a payroll file can be illustrated as follows: 7 binary bits represent an alpha-numeric character. Many of these characters are necessary to form the item containing the payroll data pertaining to one employee. In turn, many employee items are necessary to describe the complete payroll file. The magnetic tape unit operates in blockette format but an item may be a part of a blockette, a full blockette or several blockettes in length.

2. The first item-not blockette-of every file and every reel in a multi-reel file should be an identifying label item.

3. The last item in every file should contain only the end of file sentinel. An end of file sentinel, in the strict sense is one full word of Z's. Note that 12 Z's in a pattern other than a word format, such as 6 Z's in one word and 6 Z's in the next word, will not fulfill this requirement. However, it is preferable that the last item (end of file sentinel) in every file be a full item of Z's.

4. The item following the last valid item on a tape should be the end of data sentinel which is at least one full word of %'s, preferably a full item of %'s. The item containing the end of file sentinel is considered a valid item. Thus where two files are contained on one tape, the end of file item associated with the first file, will be followed by the label item of the second file. The end of file item of the second file will be followed by the end of data sentinel item.

5. All items in a file should be designed, so that any field of information is located in the same relative position within every item in the file.

6. Although neither the memory dump provisions nor the search validation character, normally affects the Sort-Collate System, refer to the Univac File-Computer Magnetic Tape Manual for a discussion of both features.

Sort-Collate Format

Although the magnetic tape unit operates in a blockette format, the item is the unit of tape data for the Sort-Collate System. Items, which may be a part of a blockette, full blockette or several blockettes in length are compared and items are transferred, even though the tape unit operates on a blockette basis. As the length of items may be varied within a file, or a tape may contain several separate files, the following specifications must be met:

1. Item lengths permissible for use as input to a Sort-Collate System are 1/2 blockette (60 characters) or "n" blockettes where n = 1,

2, ... 127. Thus the minimum item size is 1/2 blockette and maximum item size is 127 blockettes.

2. All items in each file must have their identifying data arranged in the same pattern.

3. A tape to be used in sorting operations (automatic sort and sequence checking) must contain only one file. If an attempt is made to sort a multi-file reel, the two files will become intermingled on the output tape. The reason for this is that only an end of data sentinel (%'s) will stop the sort-collate unit in sorting operations. As the end of data sentinel appears only at the end of the last file, the sort-collate unit will regard the end of file sentinels and the second file as data, and will sort them according to their proper sequence. If an end of data sentinel is inserted between the two separate files, the first file can be sorted, but there is no way in automatic sorting operations to proceed to the second file.

4. All items in files to be sorted or checked for sequence must be of the same length. The item length for all sorting and collating operations is plugboard defined (thus some plugboard wiring is always necessary), however in the automatic sorting operations no method of varying item length is available. In a plugboard defined collation program the items in a file need not be of the same length with one exception, as the item length can be varied by means of the collation program. The exception is that items of 1/2 blockette length cannot be collated with files containing any other item length.

5. In the label item on a reel of tape, the data used for labeling must be, if possible, located in character positions other than those used for the identifier. These identifier positions should contain ignore codes, (the lowest magnitude characters) since this guarantees the recording of the label item first on the output tape. If it is not possible to have ignore codes in the identifier positions, then the magnitude of the identifying characters must be chosen so that the label item will be of the lowest magnitude of all the items in the file.

6. End of file (Z's) and end of data (%'s) sentinels must appear in all the identifying character positions in the sentinel items, as well as meeting the regular sentinel requirements of having a word of 12 Z's or %'s. This is the reason for recommending that the sentinel item be a full item of Z's or %'s, since if it is a full item of Z's or %'s all necessary conditions are met.

7. End of file sentinels should be recorded as a full item of valid characters. As it is possible to have more than one file on a tape, the collation program may initiate another transfer process after receiving the end of file sentinel. Since the transfer process handles an item of data, the end of file sentinel should be an item to avoid mingling data from the next file with this sentinel item.

The end of data sentinel does not necessarily have to be of full item length, although this is preferable, since receipt of this sentinel by the sort-collate unit automatically prohibits initiation of most processes.

8. An end of data sentinel item must be recorded as the last item on every input tape.

9. In processing multiblockette items, for sorting operations or collating operations which make use of a comparison with "L" (the last item recorded), the identifier must be in the first and last blockettes of each item.

10. In the sorting sequence, a space code will be smaller than a zero. Thus caution is necessary, when intermingling space codes and zeros, to insure the desired results.

THEORY OF OPERATION OF UNIVAC FILE-COMPUTER MAGNETIC TAPE UNIT

The fundamental purpose of the Univac File-Computer Magnetic Tape Unit is to read, record and position Mylar magnetic tape. The magnetic tape unit, when under control of the central computer, can execute various input-output instructions. The tape units when under control of either the central computer or the sort-collate unit also automatically provides for the following special conditions:

1. bad spot detection,
2. beginning and end of tape detection,
3. end of file sentinel detection,
4. end of data sentinel detection,
5. automatic blockette counting and checking,
6. parity checking, and
7. tape erasure in writing operations.

Discussion in this manual will be limited to use of the magnetic tape units under control of the sort-collate unit. Refer to the Univac File-Computer Magnetic Tape Manual for a discussion of use of the tape units under control of the central computer.

The magnetic tape unit reads and records data one line at a time. Each line consists of a 7 bit character. Figure 5 is a diagram of the Theory of Operation of the Magnetic Tape Units. The theory of operation of the magnetic tape units can be illustrated by following the sequence of events in a read operation. The tape unit whether under control of the Sort-Collate System or the central computer, functions in the following manner:

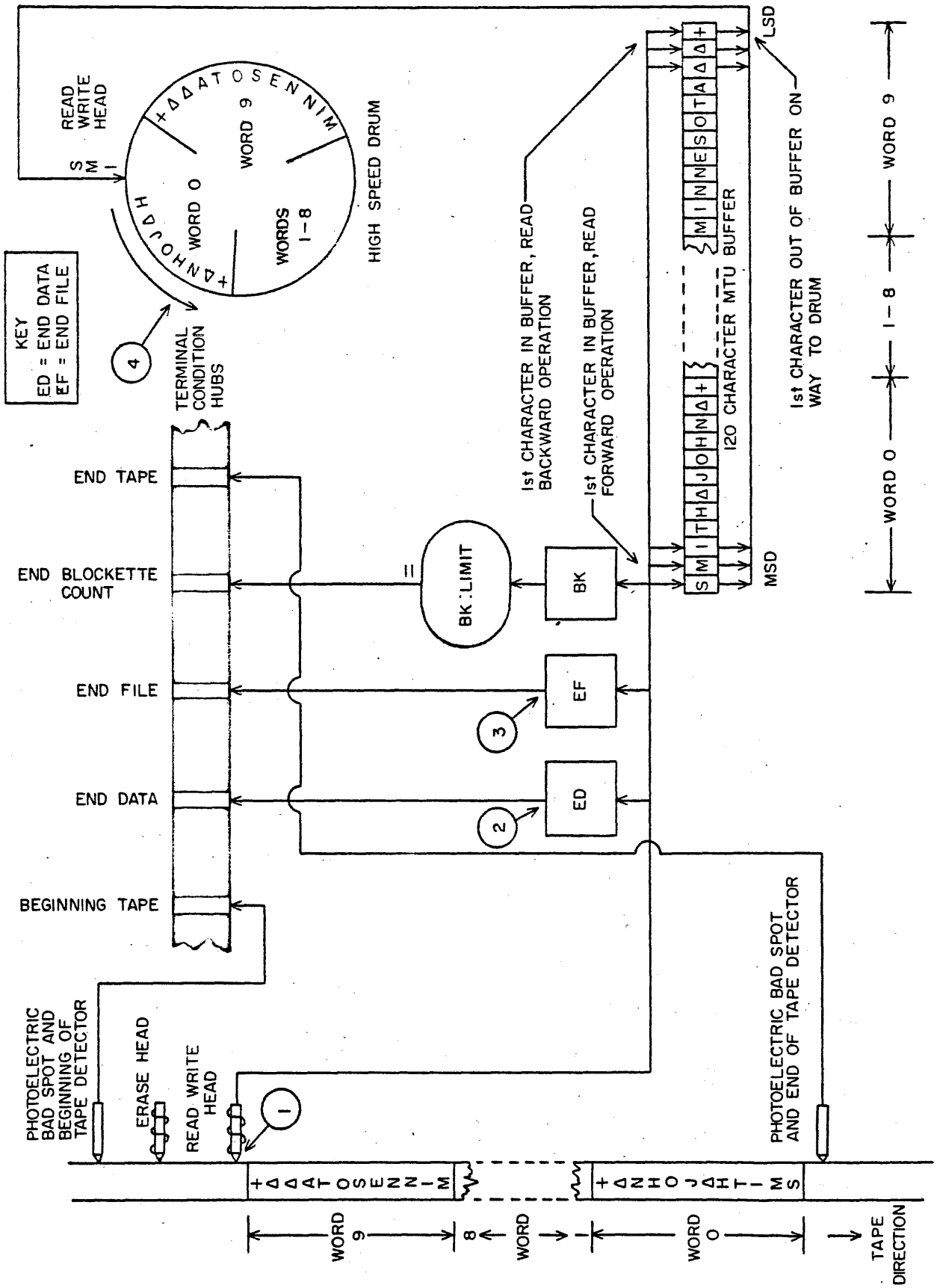


Figure 5. Theory of Operation of the Magnetic Tape Units

1. The tape unit starts the tape moving past the read/write head in a forward direction.

2. 120 lines (characters) are read a line at a time, the information is checked for parity, for end of data and end of file sentinels and blockette limits. The data then flows into the magnetic tape unit's 120 character core buffer.

3. If a bad spot should be detected, the tape unit will automatically bypass the bad spot.

4. If any of the seven special conditions is detected, such as beginning of tape, a signal (usually used for program variance), is sent to the magnetic tape control panel. When under control of the Sort-Collate System, the end of file, end of data and end of (blockette) count signal will also be sent to the sort-collate plugboard.

5. When the tape units are under control of the Sort-Collate System, the loading of the tape buffer completes the sequence of events. When the tape units are under control of the central computer, the sequence of events continues with the flow of data from the buffer, least significant digit first, to the input-output track connected to the magnetic tape unit in the central computer.

In addition to automatically checking parity, the two other automatic checks are the 120 count check on each blockette processed and a parity check during rewind operations. If an error is detected, the processing of a current blockette is repeated. If a second attempt fails, a third and final try is automatically made. Provision is thus made for automatic recovery from most tape failures due to minor or temporary tape imperfections or possible momentary equipment failure.

Chapter III

SORTING AND COLLATING OPERATIONS

GENERAL

The special-purpose function of the Sort-Collate System is the ordering of magnetic tape data which consists basically of two actions:

> a comparison of two or three units of tape data to determine the difference in magnitude between them; followed by
>
> a transfer of one or more units of tape data to place them on other tape or tapes in some relationship to their magnitudes; i.e., in accordance with the pre-established rules.

Previously, the ordering of tape data was defined as consisting of four separate types of activities; namely, sequence checking, sorting, merging and extracting. The sequence checking and sorting activities were labeled sorting operations and the merging and extracting activities were labeled collating operations. This distinction was based partially on the type of activity and partially on the fact that sorting operations were defined by an automatic internally wired ascending sort routine, and the collating operations were plugboard defined.

Tape Unit Assignments

The Sort-Collate System uses four tape units whether or not it is performing sequence checking, sorting, merging or extracting activities. The specific functions of each tape unit in the four types of activity is given in Table 2 (Sort-Collate Tape Unit Assignments). The sort-collate unit controls the input and output function of each tape unit, and executes the internal or plugboard programs required to order the tape data.

Item Length

Although the magnetic tape unit operates in a blockette format, the unit of data of the Sort-Collate System is an "item" which may be 1/2 blockette, a full blockette or several (up to and including 127) blockettes in length.

In all operations of the Sort-Collate System, plugboard wiring is necessary to specify the item length and the compare positions. In sorting operations, only these hubs must be wired. In collation operations, the program is wired on the plugboard in addition to specifying the item length and compare positions.

The Sort-Collate System refers to the item length defined on the plugboard each time it begins a new step in the program (plugboard or internal). If the item length specified at that time is 4 blockettes, or 480 characters, and the step calls for a transfer, the system automatically transfers 480 characters, but in a blockette format.

Table 2. Sort-Collate Tape Unit Assignments

Oper. Defined	Type Oper.	Name of Operation	Tape Unit	Function	Contents
INTERNALLY WIRED ROUTINE	SORTING BY COLLATION	Sequence Checking	MTU I	input	File to be checked
			MTU II	not used	----------
			MTU III	output	If file to be checked is already in ascending sequence, the file is duplicated on MTU III: if the file to be checked is not in ascending sequence, all of its items are rewritten, but some are on MTU III, and the others are on MTU IV.
			MTU IV	output	
		Sort	MTU I	input & intermediate storage	File to be sorted
			MTU II	intermediate storage	----------
			MTU III	intermediate storage and output	Sorted File
			MTU IV	intermediate storage	----------
PLUGBOARD PROGRAM	MERGING	Two-File Merge	MTU I	input	Master File A
			MTU II	input	Master File B
			MTU III & IV (either or both can be used)	output	Merged File
		Three-File Merge	MTU I	input	Master File A
			MTU II	input	Master File B
			MTU III	input	Master File C
			MTU IV	output	Merged File
	EXTRACTION	Extraction on the basis of M = K, M > K, or M < K	MTU I	input	Master File (M)
			MTU II	input	Key File (K)
			MTU III & IV (either or both can be used)	output	Extracted File
		Extraction between limits: $K_1 < M < K_2$	MTU I	input	Master File
			MTU II	input	Key File (K_2)
			MTU III	input	Key File (K_1)
			MTU IV	output	Extracted File

If the item length involved in a transfer step is 1/2 blockette, or 60 characters, the sort-collate unit performs a 60 character transfer, automatically cycling through the buffer of the source tape unit and the buffer of the destination tape unit. Thus the sort-collate unit "remembers" in which half of the source tape unit's buffer to get the 60 character item and it "remembers" in which half of the destination tape unit's buffer to place the item. A new blockette will be read, or a buffer written on tape, only when both halves of the blockette have been processed.

The magnetic tape units automatically provide for sentinel detection (end of file and end of data) as well as comparison of the blockette counter with its prescribed limit. If one of these three conditions is detected, a pulse is sent to the sort-collate plugboard, but the process is not interrupted by detection of this condition; it continues in the normal manner to the end of the process. Thus, for example, detection of an end of blockette count during the transfer of the first or subsequent blockettes of a multiblockette item does not interfere with the normal processing of that item. This condition is "remembered" in the circuitry of the sort-collate unit by wiring to the "in" of the terminal selects. The topic will be discussed in detail in Chapter IV (Repertoire of Instructions).

Items must be the same length in sorting operations. In collating operations items need not be the same length except that a 1/2 blockette item size cannot be collated with any other item size.

Identifier Character Positions

The Sort-Collate System compares items. However, when comparing items only certain identifying character positions, plugboard defined, are actually compared.

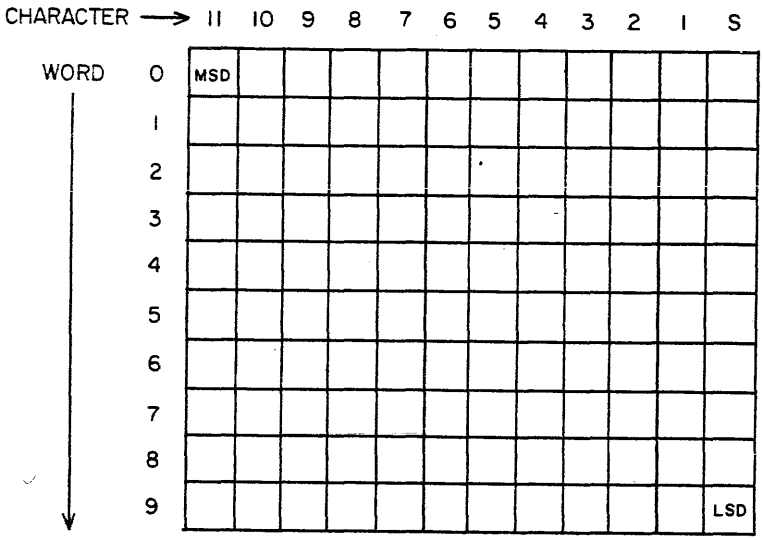
Each item, in addition to also defining a given file entry, such as an employee item in a payroll file, must contain identifying data (such as the employee's clock number) to distinguish it from the other items in a file. This identifying data may also be termed "compare position", "identifier" or the "key", in other computer literature.

The distinction between the identifying data and the prime set of identifying data must be explained. For 1/2 blockette or full blockette size items, the same compare positions always define the "identifier"; however, in a multiblockette item the same compare positions in each of the several blockettes yield both the "identifier" (in the first and last blockettes), and data (in the intervening blockettes). To differentiate between the true identifier and data, the true identifier, (the clock number) is known as the prime set of identifying data. Thus for 1/2 blockette and full blockette size items, the prime set (in this case the only set) of identifying data appears in the item; however, in multiblockette items, the prime set of identifying data is contained only in the first and last blockettes of the item.

When items are compared, only each one's prime set of identifying data is used. For blockette or multiblockette items, this prime set of identifying data can

be anywhere from 1 to 120 characters in length; for 1/2 blockette items, this prime set of identifying data can be from 1 to 60 characters in length.

Identifiers are defined on a word and a character basis within the blockette. Each of the 10 words is composed of 11 characters, plus sign. In the case of a blockette or multiblockette item, word 0, character 11 is the most significant compare position. This corresponds to the character written first on the tape when the item was recorded.

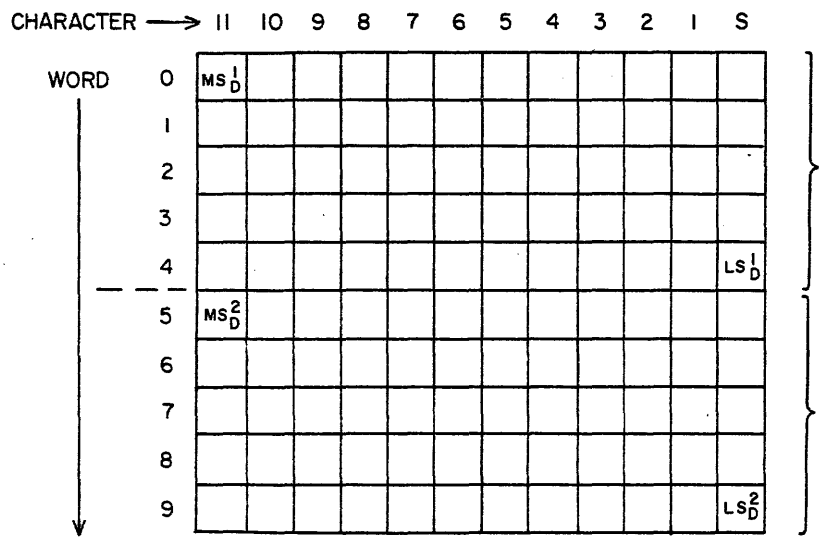


Blockette or Multiblockette Item

The most significant digit (MSD) appears in word 0 character 11 and proceeds in a descending order to the least significant digit (LSD) in word 9 character S.

Word 0, character 10 is the next most significant compare position, etc. Word 9, character S (sign) is the least significant compare position. This corresponds to the last character written on the tape when the item (or, in the case of multiblockette items, the first blockette of the item) was recorded.

In the case of 60 character items, exactly two items are stored in each blockette on the tape. Accordingly, the 120 compare positions are divided into two parts: word 0, character 11 through word 4, character S are used for the first item; and word 5 character 11 through word 9, character S are used for the second item.



First Item in 60 Character Item Design
MSD appears in word 0 character 11 and descends to LSD in word 4 character S.

Second Item in 60 Character Item Design
MSD appears in word 5 character 11 and descends to LSD in word 9 character S.

Word 0, character 11 is the most significant compare position for the first item in the blockette; and word 4, character S is the least significant compare position for the first item in the blockette. Word 5, character 11 is the most significant compare position for the second item in the blockette; and word 9, character S is the least significant compare position for the second item in the blockette. When 60 character items are used in any sort-collate operation:

1. all items in each file must be 60 character items, and

2. both halves of the compare position hubs must be identically wired.

Regardless of the item length employed, the compare positions plugged need not represent adjacent character positions in the prime set of identifying data. That is, the prime set of identifying data can be partitioned. In the case of items of 120 characters or more, 4 groups of compare positions can be specified. In the case of 60 character items (where two identical sets of compare positions must be plugged) only 2 groups of compare positions can be specified. Compare positions within any group represent adjacent character positions.

The relative importance of any compare position or group cannot be altered by wiring. For example, word 0, character 11 will always be more significant than word 0, character 10 etc. This fact means that in planning item design where more than one compare group is to be used, consideration must be given to the order, most significant to least significant, in which the data will be compared.

SEQUENCE CHECKING

In a sequence checking activity, the internally wired routine checks the sequence of the key or keys of each item in a file according to the sorting sequence. In the SORT MODE which includes sequence checking and sorting, all of the results of the three-way comparison are used internally while in the PROGRAM COLLATE MODE, the results are brought out to the plugboard and can be used at the discretion of the programmer.

The sort-collate unit is set to SORT MODE for sequence checking. The reel to be checked is mounted on MTU I. A single pass is made through the tape, and if the file is in ascending sequence, the following events occur:

1. The sequenced file is duplicated on MTU III,

2. The sort-collate unit automatically rewinds all MTUs although actual movement is visibly detected only for MTU I and MTU III (all sort-collate rewinds are with interlock), and

3. The "END SORT" lamp on the sort-collate control panel is lit.

If the file is not in ascending sequence, the following events occur:

1. Only MTU I is rewound with interlock,

2. The master file is duplicated on MTU III and MTU IV in accordance with the internal routine,

3. The "END SORT" lamp is not lit.

At this point, if a sorted tape is required, a sort routine is initiated. The tape unit assignments shown in Table 2, (Sort-Collate Tape Unit Assignments) show MTU II as not being used in a sequence checking activity. This would seem to indicate that MTU II need not be considered in sequence checking.

Although no visible use is made of MTU II, an empty reel of tape must be mounted on this tape unit. This is due to the fact that comparisons within the sort-collate unit read all four tape unit's buffers. If no reel is mounted on MTU II, the tension arms on the tape unit close indicating a "broken tape" condition which puts the tape unit in an abnormal status. This condition puts the unit in a NOT READY status which prohibits the reading of the buffers and stops operations. Since this is true of all sort-collate operations, each tape unit must have a reel mounted regardless of whether or not the tape unit is used.

SORTING

Sorting is the rearranging of items of information according to the sorting sequence of the key or keys in each item in the file. In sorting operations the sort-collate unit is set to SORT MODE. The internally wired ascending sort routine employs a combination of extracting and merging to sort a file in strict relation to magnitude. Only one reel is sorted at a time. The sorting activity requires several passes through the tape data. The number of passes depends on the number of items to be sorted, the length of the items to be sorted, and the number of natural sequences already in the items. This topic will be discussed in detail in Chapter V (Timing Estimates For the Sort-Collate System).

The sorting activity consists of a dispersion run and sorting passes. The dispersion run is the sequence checking activity. In sequence checking, if the file is not in sequence, the master file is duplicated on MTU III and MTU IV (the actual dispersion), and only MTU I is rewound. Thus sequence checking is always a part of every sorting activity, and would be regarded as the first pass of the sort. These activities are graphically illustrated in Figure 6 (Sequence Checking and Sorting Flow Chart).

At this point MTU I, on which the original file is mounted, is rewound with interlock. Although it is not essential to replace MTU I with an empty reel, it is strongly advised that this be done to retain the original master file. As the subsequent sorting operation uses MTU I for temporary storage, the

Initial Conditions: MTU I contains the file to be checked for sequence or to be sorted and MTU II, MTU III and MTU IV contain blank reels of tape.

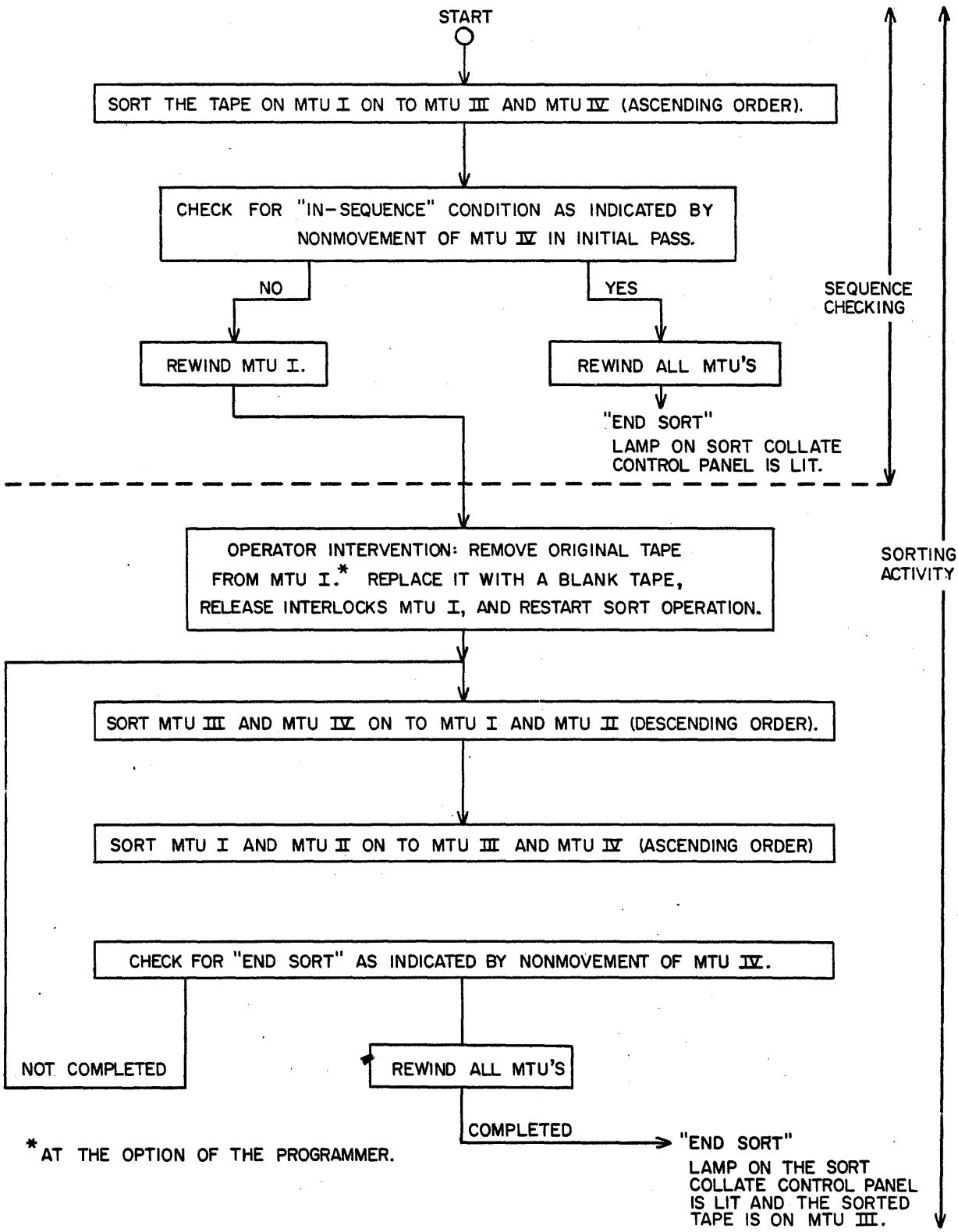


Figure 6. Sequence Checking and Sorting Flow Chart

rewind with interlock is a check to prevent accidental writing over the original reel. The fact that an operator must release the interlock on the tape unit spotlights this automatic checking device. Normally the reel is changed, the interlock is released, and the sort is initiated from the sort-collate control panel.

Once the sort is thus initiated, the sort-collate unit is operating in a START mode (as opposed to a STOP mode). With the System operating in a START mode, accidental depression of any button except the STOP button does not disrupt sorting activity nor collating activity. The sorting continues, in both forward and backward tape passes, until completion when the following events occur:

1. The sorted file is on MTU III,

2. All four tape units are automatically rewound with interlock, and

3. The "END SORT" lamp on the sort-collate control panel is lit.

MERGING

Merging is the combining of two or more ordered (sorted) files to produce a combined ordered file. Merging activities operate under control of a plugboard defined collation program. Both two-file and three-file merges can be plugboard defined. Even though a two-file merge may use only three tape units, it is necessary to mount a reel on all four magnetic tape units as explained in the topic on Sequence Checking in this chapter.

The Sort-Collate System is set to the PROGRAM COLLATE mode for both merging and extracting activities. This is the only mode in which "computer alert" operations can be initiated. The programmer provides for computer alert as a part of the sort-collate plugboard defined instructions. Detailed programming for a computer alert is discussed in Chapter IV (The Repertoire of Instructions).

The purpose of a computer alert operation is to stop the collating operations when certain specified conditions are met in the collating program. These conditions indicate that data, which requires processing, has been located on the tape. The data, is then made available to the central computer for processing.

Although the sort-collate unit does not have a demand station position, it has certain circuitry very similar to that in a demand station. In computer alert operations, MTU I's demand station is "borrowed" by the system to notify the computer that computer alert has been initiated. When a computer alert hub on the sort-collate plugboard is pulsed, the following events occur:

1. Collation (or extracting) ceases,

2. A copy of the 120 characters held in each tape unit's buffer is written on the input-output track associated with that tape unit, and

3. Control of the four tape units is then turned over to the central computer, all the demand station control lines are released by sort-collate control, and data transmissions to and from each tape unit's associated input-output track take place under computer control.

When the computer has completed processing the data, it can demand any MTU to give it an instruction and/or revert subsequent control of all tape units to the sort-collate unit.

Either case will initiate the transfer of the tape unit control from the central computer to the Sort-Collate System but only an instruction will send up-dated data to one MTU. If other MTUs are to receive instructions, each must be demanded separately, and given the instruction before the computer reverts control to the sort-collate unit. The computer alert sequence is discussed in detail in Chapter VI (Operating the Sort-Collate System).

The collation program can be continued after a computer alert operation, but the sort-collate unit does not attempt to resume collating until all operations specified by the computer are completed. When the magnetic tape units have finished with the computer defined operations, the sort-collate unit assumes complete control of each tape unit, and collating commences from the point specified by the wiring of the collation program.

EXTRACTING

Extracting is the production of one or more selective files from a master file by means of either selecting data which may be larger than, equal to, or smaller than one key, or selecting data which falls between the ranges of two separate keys.

In a single key extracting program, the master file is mounted on MTU I, the key file is mounted on MTU II, and the extracted file can appear on either or both MTU III and MTU IV. Of course, if only one tape unit is used for output, a blank reel must be mounted on the other tape unit. In a two key extracting program, MTU I contains the master file, MTU II and MTU III contain the key files, and the extracted file appears on MTU IV.

The Sort-Collate System is set to the PROGRAM COLLATE mode for the plugboard defined extracting program. Computer alert operations in extracting are identical to those for merging which has previously been discussed in this chapter.

Chapter IV

THE REPERTOIRE OF INSTRUCTIONS

INTRODUCTION TO THE SORT-COLLATE PLUGBOARD

The Sort-Collate System control plugboard, illustrated in Figure 7 (Sort-Collate Plugboard), provides a means of defining the item length, the identifying character positions used in all comparisons, and a collating program which is used for collating and extracting activities performed in the PROGRAM COLLATE mode of operation.

Since only the item length and identifying character positions are wired on the plugboard in sequence checking and sorting activities, it is more convenient to discuss the sort-collate plugboard in terms of a collation program.

A collation program is performed only in the PROGRAM COLLATE mode, and defines the merging or extracting activities to be performed. It can be broken down into several component parts including:

1. The collation step,
2. Process,
3. Plugboard hubs used in conjunction with a process,
4. Item length designation,
5. Control lines,
6. Program variance,
7. Special conditions, and
8. Miscellaneous

Various hubs or groups of hubs on the sort-collate plugboard differ in the direction of current and the type of current. Table 3 (Sort-Collate Plugboard Sections), illustrates this information in tabular form. The group of hubs that only receive and reroute current are designated as "R" under Current - Direction. The other hubs emit current and are designated as "E". Under Current - Types, "EN" stands for enable, "P" stands for pulse and "PB+" for pseudo B+ current, which for technical purposes is +35. The uses of these currents will be discussed in connection with their respective plugboard sections.

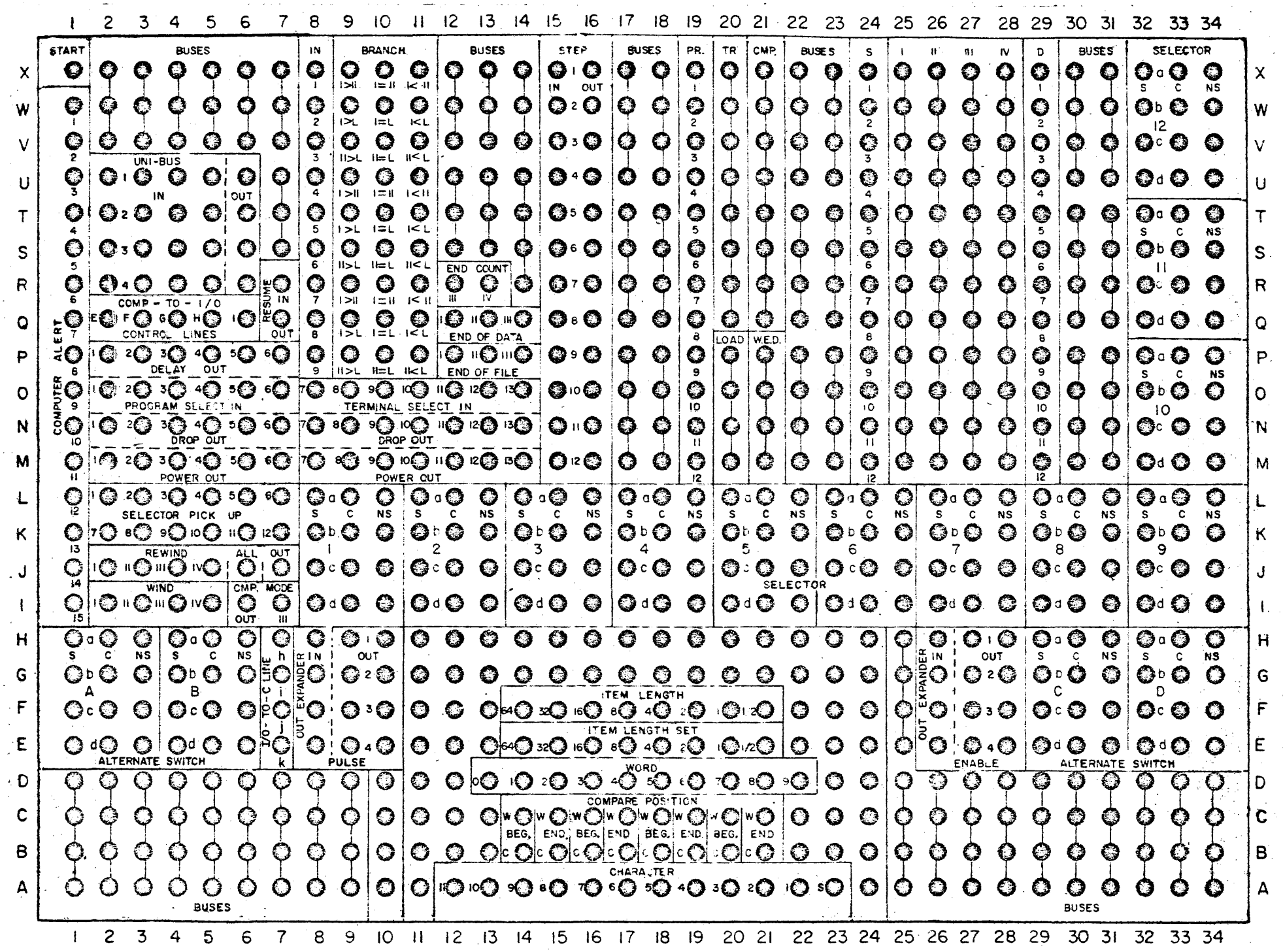


Figure 7. Sort Collate Plugboard

Table 3

Sort-Collate Plugboard Sections					
Nomenclature	Coordinates	Current Dir.	Current Type	# Hubs	Predominant Programming Use
Collation Step:					
Start	1 (one)	E	P	1	Emits when the START button on the control panel is activated after a master clear.
Step In	15 M-X	R	P	12	Initiates the collation step.
PR-Process	19 X-M	E	EN	12	Selects the process for the designated step.
S-Source	24 M-X	E	EN	12	Selects the source tape unit in the appropriate steps.
D-Destination	29 M-X	E	EN	12	Selects the destination tape unit in the appropriate steps.
I, II, III, IV	25-28 M-X	R	EN	4 sets of 12 Bussed Hubs	Specifies which MTUs are source, and which are destination tape units.
Step Out	16 M-X	E	P	12	Ending signal of a step.
Process:					
L-Load	20 P-M	R	EN	4 com.	Selects the load process.
TR-Transfer	20 X-Q	R	EN	8 com.	Selects the transfer process.
CMP-Compare	21 X-Q	R	EN	8 com.	Selects the compare process. I:II; I:L; II:L

Sort-Collate Plugboard Sections (Cont.)					
Nomenclature	Coordinates	Current Dir.	Current Type	# Hubs	Predominant Programming Use
WED-Write End Date	21 P-M	R	EN	4 com.	Selects the write end of data process.
Wind I II III IV	2-5 I	R	P	4	Initiates the appropriate wind.
Rewind I,II,III,IV All	2-7	R	P	5	Initiates the appropriate rewind.
Out	J	E	P	1	Emits step pulse when rewinds are complete and interlocks are manually released.
CA-Computer Alert	I W-I	R	P	15	Sets sort-collate's (MTU I's) demand station to READY, activates the specified high speed control line(s), and clears the SC mode in MTUs.
Plugboard Hubs Used in Conjunction with a Process:					
Compare Positions	14-21 B-C				Specifies which character positions are to be the identifier or key.
Begin W C		E E	PB+ PB+	4 4	
End W C		E E	PB+ PB+	4 4	
Word	13-22 D	R	PB+	10	Specifies the word for use with the compare positions.
Character	12-23 A	R	PB+	12	Specifies the character for use with the compare position.
Branch In Out	8-11 X-P	R E	P P	3 sets of 9 outs each	Probes the results of the compare step.

Sort-Collate Plugboard Sections (Cont.)					
Nomenclature	Coordinates	Current Dir.	Current Type	# Hubs	Predominant Programming Use
Compare Mode Out III	6-7 I	E R	PB+ PB+	1 set	Specifies that MTU III's buffer is to be used in the compare process as the last buffer.
Resume In Out	7 R-Q	R E	P P	1 set	Starts program again after a computer alert operation.
Item Length Designation:					
Item Length	14-21 F	R 1/2 R	PB+ P	1 7	Specifies the item length.
Item Length Set	14-21 E	E 1/2 E	PB+ P	1 7	Specifies the item length.
Control Lines:					
Computer-to-I/O Control Lines	2-6 Q	E	P	5	Carries signals from the computer to the sort-collate unit.
I/O-to-Computer Control Lines	7 E-H	R	PB+	4	Sends control signal to computer plugboard during computer alert operation on the Model 0.
Program Variance:					
Selectors Common Select Non-Select	Various	R E E	Any	12 sets of 4	Routes current one of two ways depending on whether or not the selector is "activated" or "picked up".
Alternate Switch Common Select Non-Select	1-6 29-34 E-H	 R E E	Any	4 sets of 4	Routes current one of two ways depending on the setting of a switch on the sort-collate control panel.

Sort-Collate Plugboard Sections (Cont.)					
Nomenclature	Coordinates	Current Dir.	Current Type	# Hubs	Predominant Programming Use
Terminal Selects	8-14				Handles terminal signals which are used to pickup selectors. Provides a means of dropping out these selectors.
In	O	R	P	7 sets	
Power Out	N	E	PB+		
Drop Out	M	R	P		
Program Selects	2-7			6 sets	Converts a pulse to PB+ for holding in a selector. Delays a pulse until the selector is activated. Provides a means for dropping out the selector.
In	O	R	P		
Power Out	M	E	PB+		
Delay Out	P	E	P		
Drop Out	N	R	P		
Selector Pickup	2-7 K-L	R	PB+	12	Sets the corresponding selector to the select side.
Special Conditions:					
End File I, II, III	12-14 P	E	P	3	Emits when end of file condition occurs on the appropriate tape unit.
End Data I, II, III	12-14 Q	E	P	3	Emits when the end of data condition occurs on appropriate tape unit.
End Count III - IV	12-13 R	E	P	2	Emits when the end of count condition is reached on appropriate tape unit.
Miscellaneous:					
Pulse Out Expander	8-10 E-H		Pulse Only	4 sets	One pulse "in" produces two amplified diode protected "outs".
1 in		R			
2 out		E			
Enable Out Expander	26-28 E-H				One enable "in" produces two amplified diode protected "outs".
1 in		R	EN	4 sets	
2 out		E			

Sort-Collate Plugboard Sections (Cont.)					
		Current			
Nomenclature	Coordinates	Dir.	Type	# Hubs	Predominant Programming Use
Buses	Various	Any	Any	Various	Facilities wiring multiple ins or outs.
Unibuses 4 in 1 out	2-6 R-U	R E	Any	4 sets	Any one of 4 diode protected "ins" produces one diode protected "outs".

THE COLLATION STEP

The required combination of step in, process, source, destination and step out hubs, are wired to define a collation step. The start hub is not a part of every collation step since it is used only to initiate the beginning step in the program.

Start Hub

The start hub emits a pulse only when three events have occurred in the following order:

1. The Sort-Collate System is in a STOP mode of operation (as opposed to a START mode of operation), or is put in such a mode by depressing the STOP button on the sort-collate control panel,

2. The MASTER CLEAR button on the sort-collate control panel is depressed putting the system in a "cleared" state, and

3. The START button on the sort-collate control panel is depressed.

The start pulse is then used to initiate the collation program and as such it normally would be wired to the "IN" of any of the twelve steps.

If the STOP and START buttons are depressed (with no MASTER CLEAR) then the program is reinitiated not from the START hub, but from the point where the collation program was interrupted by pressing the STOP button.

Step In Hub

The wiring of a pulse, usually from the start hub or the out hub of another step into the hub of any step, initiates that plugboard step.

PR-Process Hub

The emitting process hubs define which of the six processes are to be performed during a collation step. Process hubs, source, and destination hubs bear a direct relation to the same numbered step hubs; i.e., process hub 1 pertains only to step 1, etc.

S-Source Hub

The source hubs, labeled S, specify which of the permissible input tape units supply data for the collation step. The permissable input tape units are MTU I, MTU II, and MTU III. If for some special purpose, MTU IV is to serve as a source tape, it operates differently in the load and transfer processes as follows:

1. If the process is load it will function normally, unless the blockette to be loaded is a sentinel blockette. An end of file sentinel (EF) is always detected by the tape unit but only the EF sentinels for MTU I, MTU II and MTU III are also detected by the sort-collate unit. Thus an EF sentinel is not operative to the sort-collate unit for MTU IV, even though the blockette is loaded into the buffer of MTU IV correctly. An end of data sentinel (ED) is detected by all tape units but the ED for MTU IV is not available to the sort-collate unit, although the ED blockette is loaded into the buffer of MTU IV correctly. The end of data lockout is not effective. Since this lockout does not hinder a load process, it is possible to override the ED sentinel by another load instruction. As the load process is primarily a starting process, the first blockette is usually an item other than a sentinel item so that these special conditions do not occur often.

2. If the process is transfer, the point of caution concerns the attempted transfer of a blockette which contains the end of data sentinel. This topic is discussed under Transfer in the section on Process in this chapter.

D-Destination Hub

The destination hubs, labeled D, specify which permissible output tape units receive data as a result of the collation step.

The permissible output tape units are MTU III and MTU IV. MTU I or MTU II can be used as a destination tape unit, but it must be realized that the end of count condition (EC) for MTU I and MTU II is not available to the sort-collate unit. Thus if an EC signal is relied upon to halt writing on a tape, MTU III or MTU IV must be used.

Hubs Designated as I, II, III and IV

These hubs identify the magnetic tape unit or units for both source and destination designation purposes. All the hubs in column I are common, so that any hub I may be used to specify MTU I.

Step Out Hub

The step out hub is the ending signal of a step, and is used to control the sequencing of the collation program. The collation program need not be sequential, and the steps are reusable.

PROCESS

Every program carried out by the Sort-Collate System consists of a series of steps involving one or more of the seven processes discussed below. In collating operations all seven processes may be used according to the plugboard defined program. In sorting operations, four processes; namely load, transfer, compare and rewind with interlock, are used according to the internally wired program.

L-Load

The load process is primarily a "starting" process. It is normally used to initially load the buffer of the tape unit with data. This is necessary as the transfer and compare processes work only from the contents of the buffers.

One, any combination, or all four tape units may be designated as sources. Each blockette, transferred from the tape to the buffer of the tape unit by the load process, is scrutinized for sentinel conditions, but an EF or ED sentinel is not detected by the sort-collate unit for MTU IV. The load process, although primarily a starting process, may be used at any time within the collation program to advance a tape or tapes for deletion purposes.

TR-Transfer

The transfer process transmits an item from the buffer of one source tape to one or several destination tape units. This process assumes that the item (or, in the case of multiblockette items, that the first blockette of the item), has already been loaded into the buffer of the tape unit designated as the source; that the source and destination hubs on the plugboard are appropriately wired; and that an item length is specified by plugboard wiring on the plugboard.

A transfer process always requires specification of a source tape. Specification of a destination tape is also required unless deletion of an item is desired. When the transfer process operates for a blockette size item with either MTU I, MTU II or MTU III used as an input tape unit, the following sequence of events occurs:

1. The item in the source tape unit's buffer is transferred to the destination tape (or tapes) unit's buffer (or buffers),

2. The source tape unit reads the next item from its tape,

3. The blockette counter in the source magnetic tape unit is advanced,

4. The data is scrutinized for sentinel conditions (EF and ED),

5. The data flows into the buffer of the source tape unit.

6. If an EF sentinel is detected, a pulse is sent to the appropriate labeled hub on the sort-collate plugboard, but the process is not interrupted by the detection of the EF sentinel condition; it continues in the normal manner to the end of the process.

7. If an ED sentinel condition is detected, a pulse is also sent to the plugboard, but an end of data sentinel lockout takes effect, prohibiting the read of the next blockette from the tape into the buffer. Thus the ED blockette remains in the buffer and, in effect, it is considered to be the next blockette "read". For a multiblockette item, the ED blockette in the buffer is considered to be the second, third, etc., blockettes of the item and is transferred as such. For example, a three blockette size item which is an ED sentinel is transferred as follows:

   a) The ED blockette is read into the buffer and transferred to output,

   b) Reading the next blockette is prohibited, but the sort-collate regards the ED blockette in the buffer as the second blockette, and transfers it to output,

   c) Step b) is repeated for the last blockette, and

   d) The net result on the output tape is three blockettes of ED sentinels.

8. Simultaneously, the contents of the buffer of the destination tape (or tapes) unit is recorded on the destination tape (or tapes).

9. The blockette counter for the destination tape (or tapes) unit is advanced and then compared to the prescribed limit. When this limit is reached a pulse is sent to the appropriately labeled hub on the sort-collate plugboard, but detection of this condition does not interfere with the normal completion of the process.

10. The data is "remembered" in the buffer of the destination tape unit.

If the plugboard defined item length is a multiblockette length, the one blockette sequence described above is repeated as many times as there are blockettes in the item. Detection of the end of blockette count during the first or subsequent blockettes of a multiblockette item does not interfere with the normal processing of the entire item. The fact that there is a sentinel condition is "remembered" in the circuitry of the unit in terminal selects. This subject will be discussed in detail in this chapter under Program Variance. In this case, when the operation is terminated and the entire multiblockette item has been recorded on the destination tape, the blockette last recorded on the des-

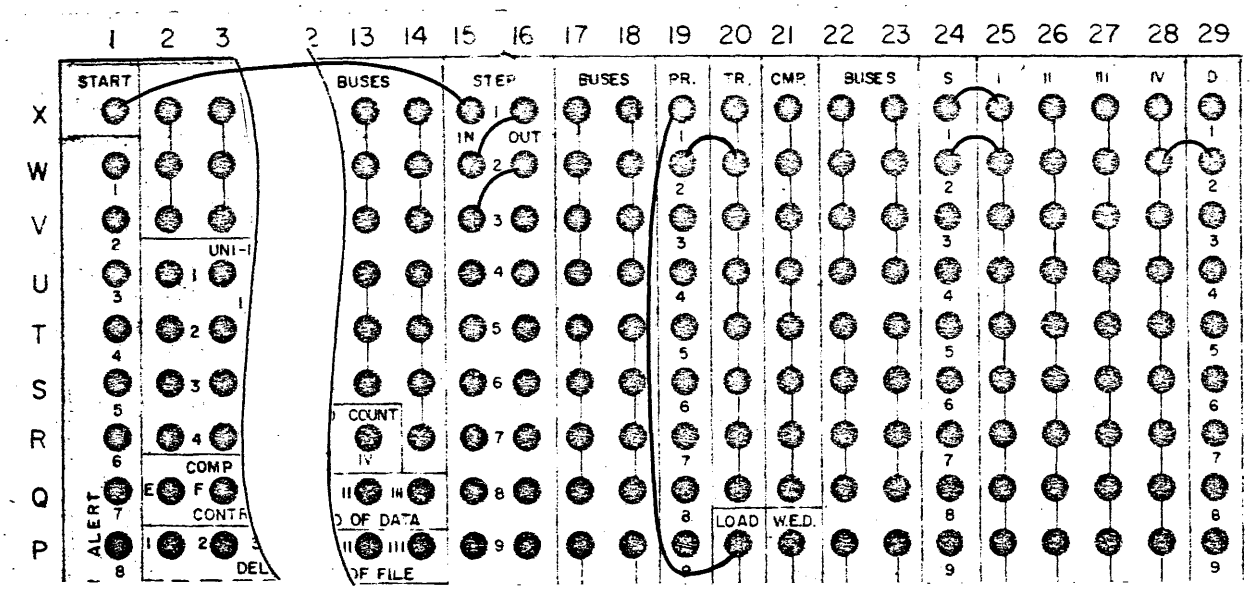
tination tape is also "remembered" in the buffer of the destination tape unit, and the blockette containing the identifier for the next item on the tape of the source tape unit is in the buffer of that tape unit.

Please refer to Chapter III (Sorting and Collating Operations) and to the topic on Item Length for a complete discussion of 60 character transfers.

The above discussion describes only MTU I, MTU II or MTU III as input source tape units. If MTU IV is to serve as input, it operates in the same manner for any item other than an end of data sentinel item. In this case, the transfer process actually transfers the contents of the buffer of MTU IV, which contains the ED blockette, to the destination buffer correctly. The ED sentinel is detected but MTU IV then ignores the end of data lockout, and actually reads the next blockette from MTU IV to the buffer. If the correct sort-collate format is noted, then the ED is a full item and the entire item is transferred. However, the blockette after the ED item probably contains "no" data or "left over" data from a prior run, in which case the tape unit "runs" through the tape searching for the next blockette until it reaches the end of count, or end of tape, or a parity or a 120 count error develops.

These programming faults can be avoided by writing one additional blockette on the tape if a 1/2 or 1 blockette size item is employed, or by writing a full valid sentinel item followed by another valid blockette if multiblockette size item is used.

The wiring example shown below illustrates the starting procedure to load the buffer of the source tape unit, and the transfer of a blockette from MTU I to MTU IV. Assume compare positions and item lengths are appropriately wired.



CMP-Compare

The compare process specifies the relative magnitude of each of three items: the item in the buffer of MTU I, the item in the buffer of MTU II, and the item in the buffer of the MTU which last (L) recorded on its tape. (The unit can be wired through the plugboard so that the third element of the comparison will always be the buffer of MTU III). The process assumes:

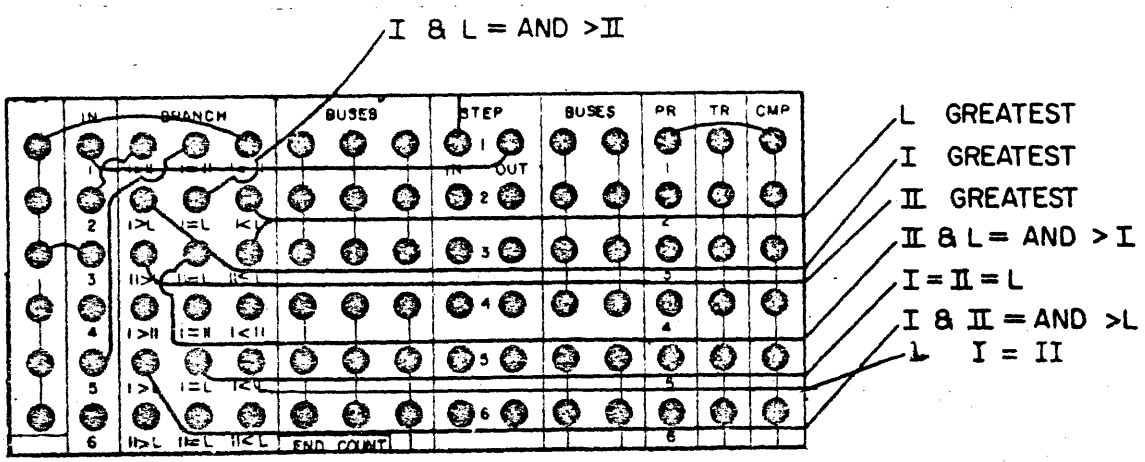
1. That the buffer of MTU I and the buffer of MTU II already contain the prime set of identifying data for items I and II respectively. The proper sort-collate format specifies that the data in the "L" (last) buffer contains the identifier for the last item recorded on tape. (If the results of I or II: L are not necessary, then the identifier in the last blockette is also not necessary, although it is recommended that the sort-collate format be adhered to in all cases; i.e., the identifier appears in both first and last blockettes of a multiblockette item.)

2. If the buffer of MTU III is always to be the third element of the comparison, it is assumed that this buffer contains the identifier for the item III.

3. It is also assumed that the identifier is defined by plugboard wiring.

Comparison is accomplished on a bit by bit basis. Comparison is suppressed in those character positions not defined by plugboard wiring; however, ignore codes do not suppress comparison in the positions in which they occur.

Neither source nor destination is specified since the operation is always a three-way compare between I : II, I : L and II : L where L is always III in



Note - Programmer should plug every possible out.

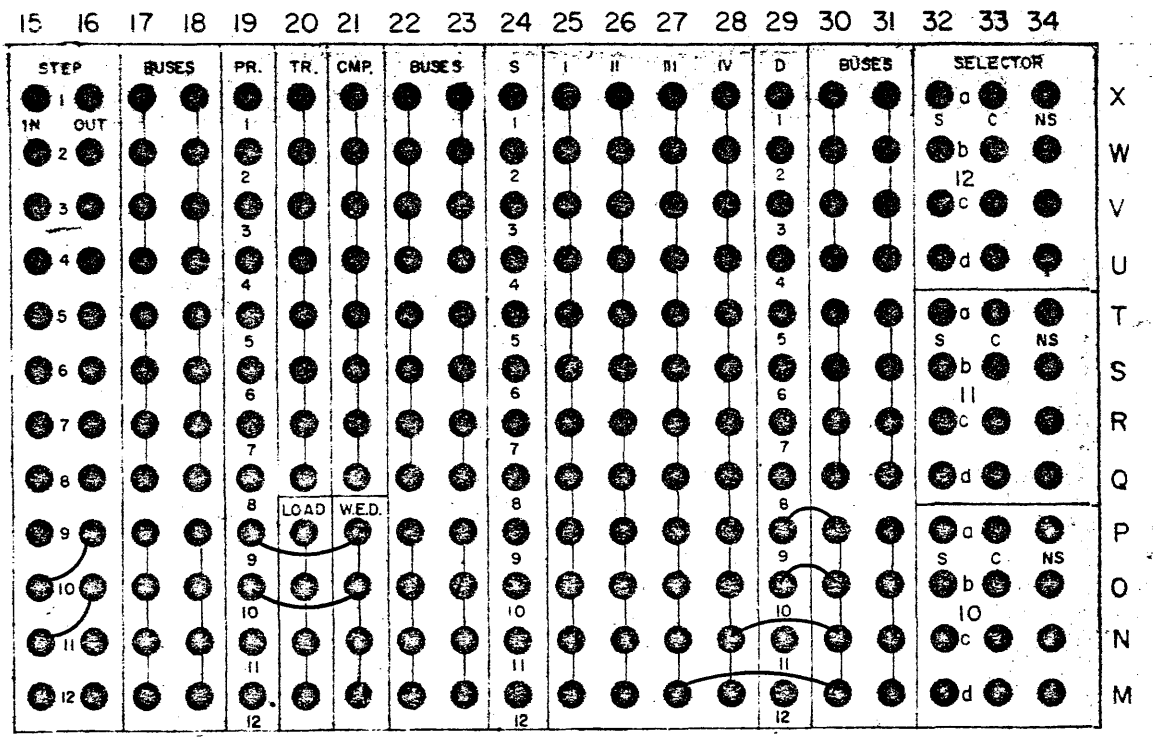
compare mode III. Three of 9 possible results (I > II, I = II, I < II; I > L, I = L, I < II; II > L, II = L, II < L) are obtained. However, if the results are to be learned and used, branch storage must be probed. Thus, the "out" of a compare step may be wired to the "in" of a branch. If the magnitudinal relationship between three values is to be established, the out of one branch may be used to probe another branch without going through another step.

As an example, assume it is necessary to determine which value is the greatest, I, II, or L. The diagram on page 36 shows the sort-collate plugboard wiring necessary to accomplish this, assuming the central computer loaded the buffers before transferring control to the sort-collate unit.

WED-Write End of Data

This process writes an item of end of data codes (%) on one or several output tapes. The Sort-Collate System automatically produces an item length of end of data codes; therefore, no source is specified. However the tape units, requiring the recording of an end of data item, must be designated as destinations. In the case of 60 character items, two write end of data processes must be programmed to insure that the item of end of data code is actually written on the output tape since the output tape buffer is written on the tape unit only when both halves of the buffer are processed.

The wiring diagram below illustrates WED on MTU III and MTU IV where 1/2 blockette item size is used. For further discussion, please refer to the topic on the Enable Out Expander in this chapter.



Wind

When one of the four wind hubs is impulsed, the appropriate tape unit winds the tape forward until the end of tape condition is detected by the tape units. Sentinel or blockette count conditions are not detected and thus ineffective.

Rewind with Interlock

Every rewind operation in the Sort-Collate System automatically interlocks the tape unit or units involved. Once an interlock is set up, it continues until it is manually released by depressing the CLEAR INTLK button on the tape unit. This is true for either DEMAND, SORT or COLLATE modes of operation.

In sequence checking operations, if the file is in sequence the Sort-Collate System automatically initiates a rewind for all MTUs. If the file is not in sequence, only MTU I is rewound with interlock.

In sorting operations all four tape units are rewound with interlock when sorting is completed.

In collating operations, rewind with interlock is provided by the programmer as a part of the plugboard program. When a rewind instruction is initiated, the entire system waits and cannot be used until the rewind is completed and the interlocks manually released, thus the collation program should not be designed to attempt other operations (by "Y" wiring) once it initiates a rewind. If possible all rewinds should be initiated at the same time by wiring the out of a step to "All". The rewind "Out" hub emits a step pulse only when the rewinds are completed, and the interlocks are manually released.

Operations are resumed after a plugboard defined collation program has been interrupted for rewind (when it is not desirable to clear the sort-collate unit by pressing MASTER CLEAR) by performing the following operations:

1. Any required reel changing is performed,

2. Press the CLEAR INTLK button on the rewound tape units, and

3. Press the START button on the sort-collate control panel. (The START button is not effective unless all interlocks are removed.) The program is reinitiated from the point specified by the wiring of the rewind out hub.

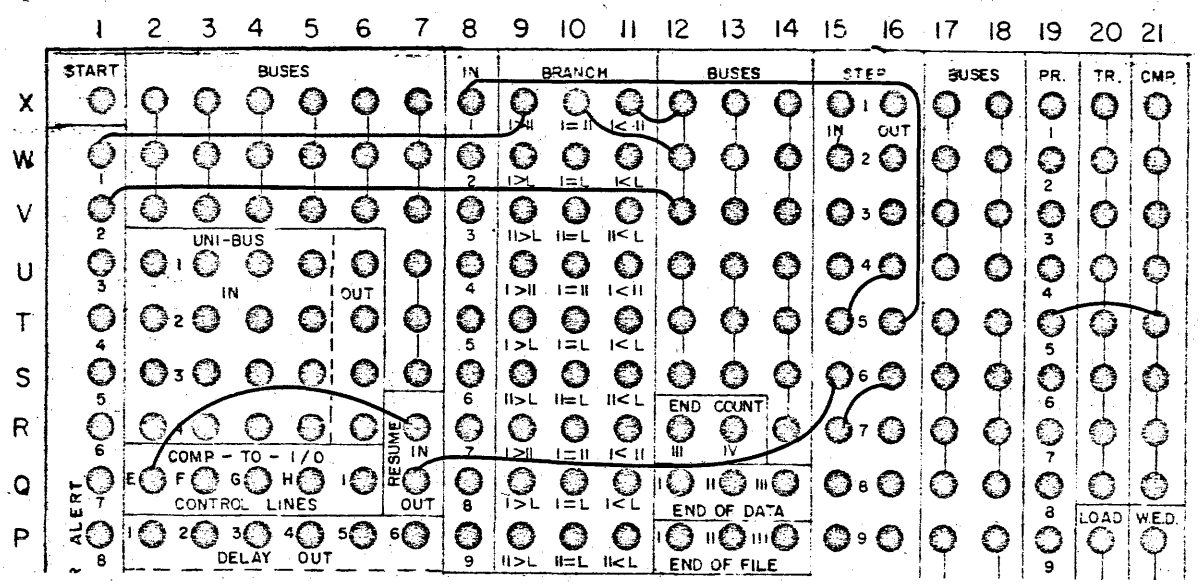
Accidental depressings of the MASTER CLEAR button do not affect the collating program as the sort-collate unit is in a START mode of operation. However, if the STOP button is depressed, then the MASTER CLEAR button is depressed, and the START button is depressed, the program is reinitiated from the start hub on the plugboard.

CA-Computer Alert

Computer alert operations provide means whereby, when certain specified con-

ditions are met in the collating program, collating ceases and the data which has been located by the sort-collate unit is made available to the central computer for processing.

The following example illustrates computer alert operations. Assume, it is essential to determine the results of I : II and this is obtained by a compare in step 5. If I > II, computer alert hub 1 is impulsed; if I $\leq$ II, computer alert hub 2 is impulsed. Further, the collation program is to be resumed at the next step, step 6. The plugboard wiring necessary to accomplish this is shown below:



The sort-collate unit does not have a demand station as such, however, it has certain circuitry very similar to that in a demand station. In computer alert operations, the sort-collate unit borrows MTU I's demand station to notify the central computer that computer alert operations have been initiated. Briefly, the impulsing of a computer alert hub on the sort-collate plugboard causes the following events to occur:

1. Collating (or extracting) stops.

2. The four tape units are notified that data transmissions are to take place to and from the computer instead of the sort-collate unit.

3. A copy of the 120 characters held in each tape unit's buffer is written on the input-output track associated with that tape unit.

4. Output control lines from the computer are switched through the sort-collate to the tape units.

5. Control of the four tape units is turned over to the central computer; i.e., each tape unit goes READY, and all of its demand station control lines are released by sort-collate control to computer demand station control.

6. The specified high speed control lines are activated.

7. The input control lines to computer are switched to the computer.

8. The computer program tests the HSCL, and transfers control to the appropriate subroutine.

After the central computer has completed processing the item, one of the computer to I/O control lines (E-I) must be impulsed. The corresponding hubs on the sort-collate control plugboard emit a pulse which must be wired to resume in. Only the resume in hub can initiate the process which reverts control back to the sort-collate unit, thus the only permissible wiring is: computer to I/O ⟶ resume in ⟶ resume out ⟶ continue program.

The resume out hub does not emit a pulse until all of the instructions given the tape units by the computer program are completed. This automatic delay relieves the programmer of any concern over this point. When the tape units have finished with the computer defined operations, the resume out hub emits a pulse, and the sort-collate control assumes complete control of each tape unit. Collating commences from the point specified by the wiring of the resume out hub. In this example collating commences at step 6.

Computer alert operations in the central computer are discussed in the last topic of this chapter under that title.

PLUGBOARD HUBS USED IN CONJUNCTION WITH A PROCESS

Compare Positions

Any sort-collate operation must specify the compare positions; i.e., the only positions in the prime set of identifying data that are actually compared. In blockette or multiblockette item size, 4 groups of compare positions, which can be of any length, can be specified; however, in a 60 character item (where 2 identical sets of compare positions must be wired) only 2 groups of compare positions can be specified.

Compare positions need not represent adjacent character positions in the prime set of identifying data, however, compare positions within a group are adjacent. Comparison is on a bit-by-bit basis, thus no two Univac characters are equal. Ignore codes do not suppress comparison in the positions in which they occur, thus an ignore code will compare equally only with another ignore code.

The four groups of Beg-End hubs do not specify the order of comparison. The relative importance of compare positions cannot be altered by wiring. Thus if word 9 character 11-S (LSW) is wired to the first group of Beg-End hubs and word 0 character 11-S (MSW) is wired to the second group of Beg-End hubs, the comparison (as far as the programmer is concerned) operates as if it were made on the most significant word first; thus the order of comparison is word 0 and then word 9.

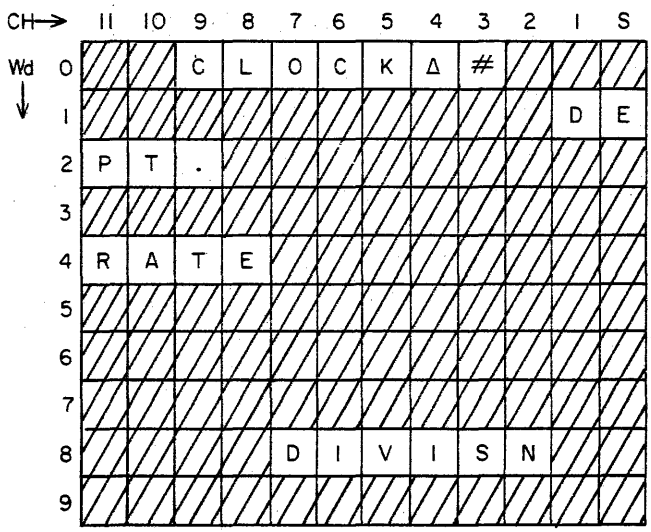
Word

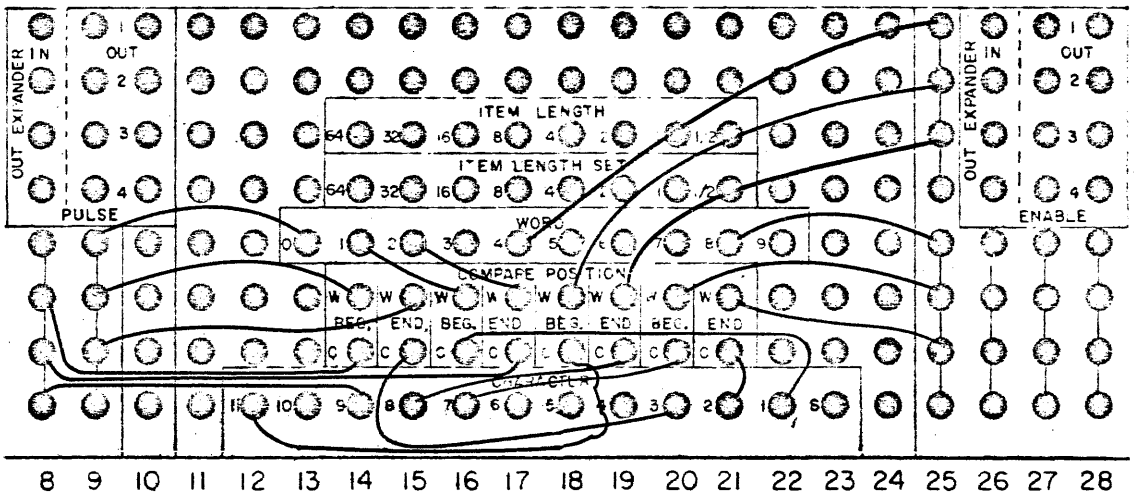
These hubs, used in conjunction with the compare positions, are wired to W-Beg and W-End and specify the word.

Character

These hubs, also used in conjunction with the compare positions, are wired to C-Beg and C-End and specify the character positions.

The following example illustrates the wiring of 4 groups of compare positions for a single blockette item size.



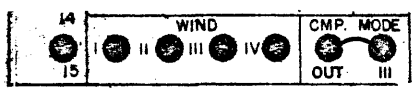


Branching

If the results of a compare step are to be learned and used, branch storage must be probed. The 3 sets (9 rows) of branch hubs are all set on one compare step. These hubs may be probed in any latter step up to the step where another comparison is performed. Please refer to the topic on Compare in this chapter for an example of the wiring of these branching hubs.

Compare Mode III

When MTU III's buffer is to be used in the compare process as the last (L) buffer, then wire the PB+ emitting hub labeled "Out" into the PB+ receiving hub labeled "III". This provides a three-way comparison between I : II, I : III (instead of I : L) and II : III (instead of II : L).



Resume

The resume hubs are the only hubs capable of reverting control from the central computer back to sort-collate control after a computer alert operation. One of the computer to I/O control lines (E-I) must be wired to resume in and the program is reinitiated from the point specified by the wiring of resume out. Please refer to the topic on Computer Alert in this chapter for an example of the wiring of the resume hubs.

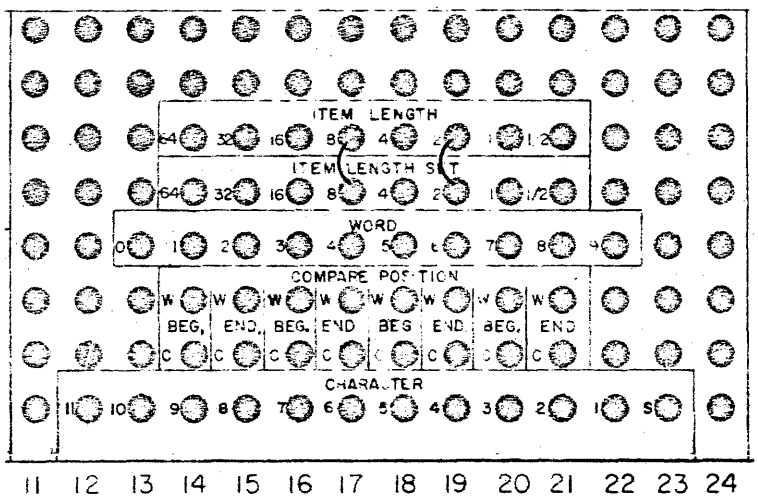
ITEM LENGTH DESIGNATION

Item Length

The item length desired must be wired in all sort-collate operations. The item length receiving hubs are numbered 1/2, (2^0=) 1, (2^1=) 2, (2^2=)4, (2^3=) 8, (2^4=) 16, (2^5=) 32, and (2^6=) 64 from which it is possible to specify an item length of 1/2 blockette or from 1 to 127 blockettes. The 1/2 hub cannot be used in combination with any other hubs.

Item Length Set

These hubs emit a pulse (the 1/2 emits PB+) which is wired to the corresponding hubs in the item length section to obtain the desired item length. Thus, an item length of 10 blockettes (1200 characters) is wired as follows:



CONTROL LINES

Computer to Input-Output Control Lines

The computer to input-output control lines carry signals from the computer to the sort-collate unit via the sort-collate unit's pseudo demand station, MTU I. Only lines E-I are used on the sort-collate unit. Upon completion of computer alert operations, the computer to input-output control lines are used (by wiring to resume in) to resume collating. Please refer to the topic on Computer Alert in this chapter for a wiring example.

Input-Output to Computer Control Lines

These control lines are used to send control signals to the computer during a computer alert operation in the Univac File-Computer, Model 0. These lines are not used in computer alert operations in the Univac File-Computer, Model 1. The

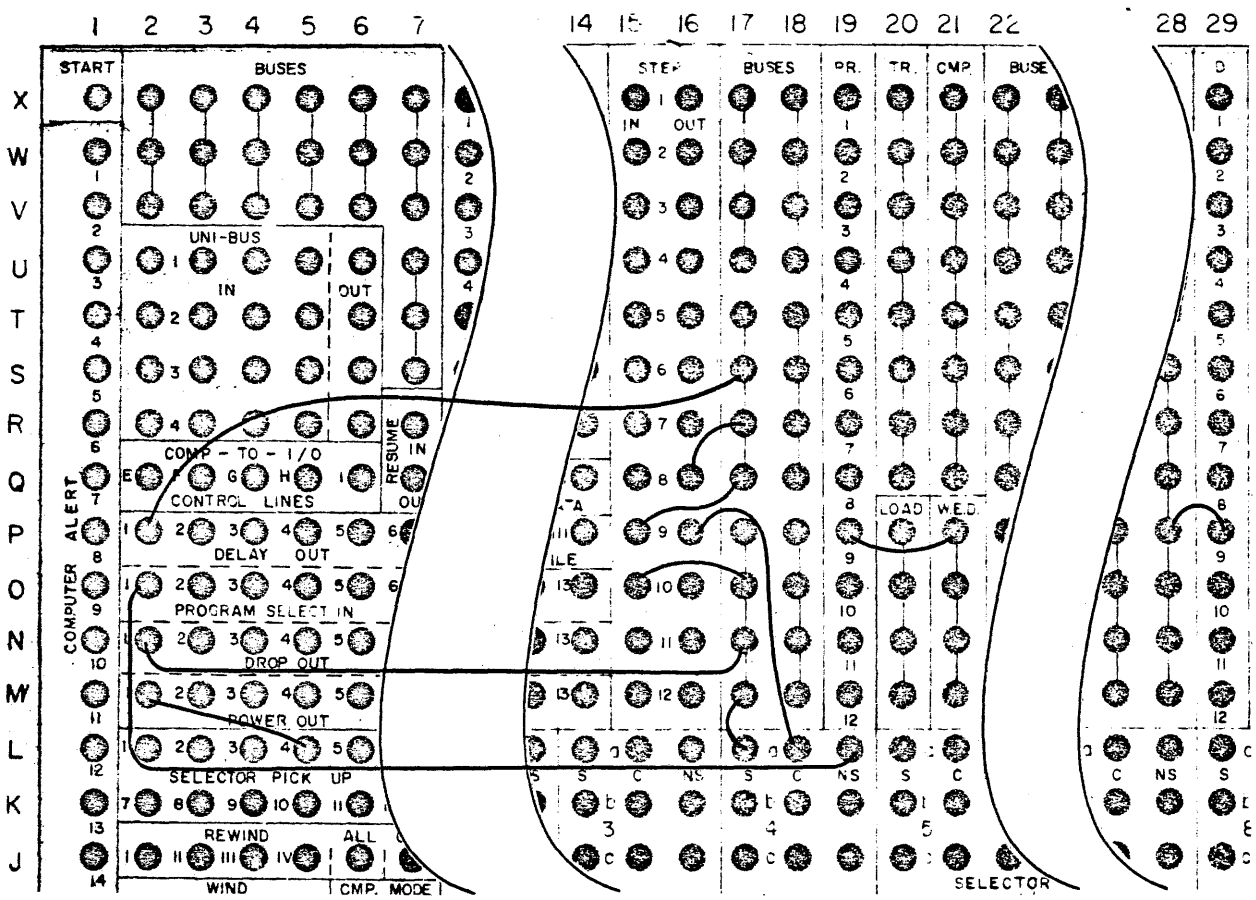
hubs h-k receive a PB+ current (a + 35) on the sort-collate plugboard which then energize an internal relay and cause a true B+ (a + 120) current to emit on the computer plugboard.

PROGRAM VARIANCE

Selectors

A selector is a two-way electrically operated switch which allows the programmer to route current one of two ways depending on whether or not the selector is "activated" or"picked up". There are 12 4-pole selectors on the sort-collate plugboard. All of the 4 poles are either picked up or not picked up at any one time. The element to be chosen is wired into the c (common). If the selector is not picked up, the choice is specified by the wiring of the ns (non-select) side; if the selector is picked up, the choice is specified by the wiring of the s (select) side.

Assume the item size is 1/2 blockette and a WED on MTU IV is to be performed. As two WED sentinels must be programmed for a 1/2 blockette size item to insure writing an item, the wiring illustrated below can be used in place of 2 separate steps:



Program selects and selector pickup will be discussed in a later topic of this chapter.

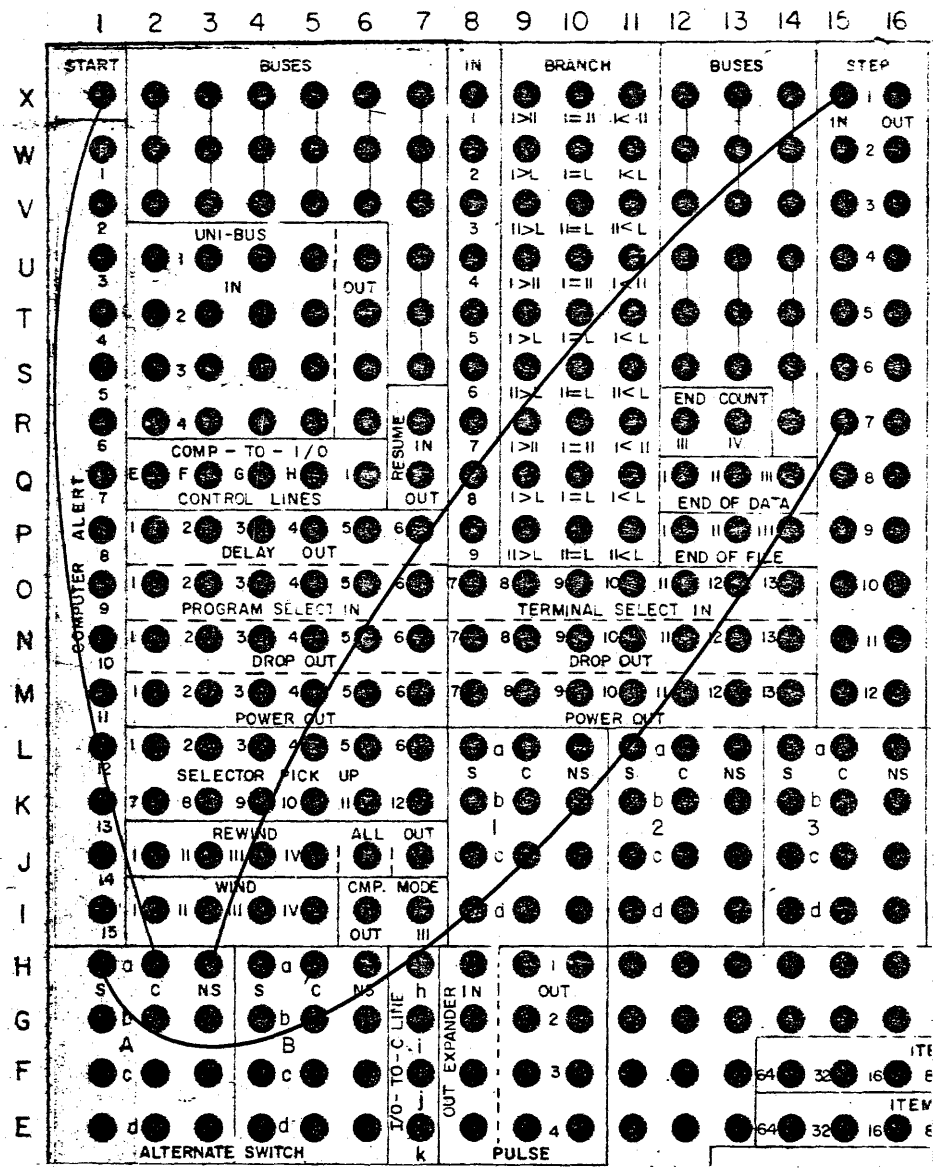
Alternate Switches

Alternate switches are manually operated selectors. Four toggle switches, one for each selector, located on the sort-collate control panel are used to pick up or not to pick up these selectors.

Assume two short programs are wired on one sort-collate plugboard. The first program begins at step 1, and the second program begins at step 7. The following example illustrates the wiring necessary to choose either program.

With Program Alteration Switch A set to OFF, the program would begin at step 1 when the START button is depressed.

With this switch set to ON, the program would begin at step 7.



Terminal Selects

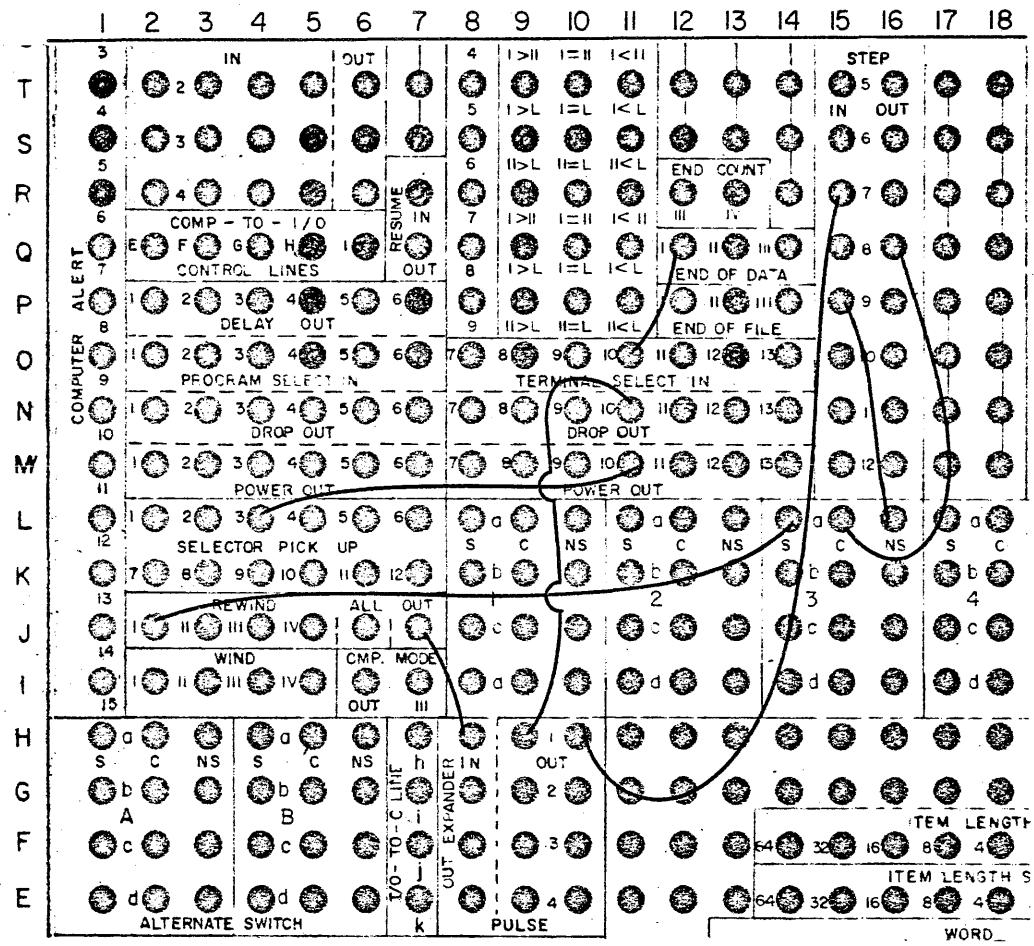
This is a special program select used only with sentinel (EF or ED) or end of count (EC) conditions. When tape movement is involved in a specified process, namely transfer or load, one of these conditions may be detected (in PROGRAM COLLATE MODE), and a pulse is sent to the appropriate labeled hub on the sort-collate plugboard. The EF and ED conditions are detected by the sort-collate unit for MTU I, MTU II and MTU III. EC is detected by the sort-collate unit for MTU III and MTU IV. Please refer to the topic on Source in this chapter for a discussion of EF and ED for MTU IV and the topic on Destination in this chapter for a discussion of EC for MTU I and MTU II.

The out of any transfer or load step should be wired to the common of a selector. The status of this selector is governed by the terminal selects. All sentinel and EC conditions must be wired to the in of the terminal selects which specify the program variation. The power out hubs do not emit a PB+, which is used to pick up selectors, until the current step is "almost" completed. As the next "step out" after the occurrence of a terminal condition is delayed 10 milliseconds until the selector is activated, the out of a step is selected.

Briefly, the program variation must be plugboard defined as follows:

TERMINAL CONDITION to TERMINAL IN	To set the terminal select so that power out can result.
POWER OUT to SELECTOR PICKUP	To pick up the selector which will cause the program variation.
OUT STEP to COMMON SELECTOR	To provide for possible program variation at this point.
NON-SELECT to MAIN PROGRAM STEP	To sequence program when no terminal condition exists.
SELECT to TERMINAL PROGRAM STEP	To sequence program when a terminal condition exists.

Assume the main program requires the out of step 8 to go to the in of step 9. When ED I condition occurs, the out of step 8 should initiate a Rewind I. After the rewind is completed, drop out the terminal select (the interlocks must also be manually released) and continue the program at step 7. The following example illustrates the necessary wiring.



Program Selects

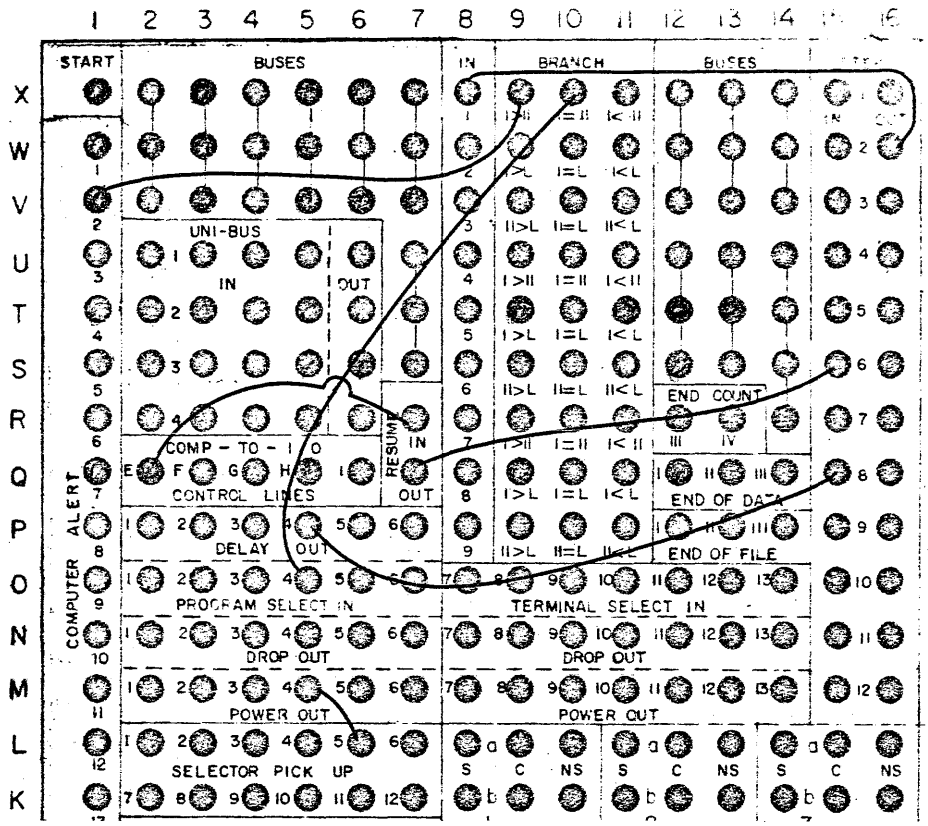
A step pulse is not of sufficient duration or power to pick up a selector. A program select converts a pulse to a PB+ sufficient to pick up a selector. The power out hub emits PB+, and is wired to selector pickup. The delay out hub continues the program after the pulse is delayed long enough to pick up the selector. Wiring into the drop out hub drops out or de-activates the selector. The power out hub (PB+) is capable of picking up all twelve selectors on the sort-collate plugboard. Any program select may be used. The wiring shown in the topic on Selectors in this chapter illustrates one wiring example.

Selector Pickup

The twelve selector pickup hubs correspond to the same numbered selectors on the sort-collate plugboard. A PB+ wired to any one of these hubs will pick up that particular selector. The topic on Selectors under the section on Program Variance in this chapter, illustrates one wiring example.

Assume a compare is made and if I > II computer alert hub 2 is impulsed. The program is to be resumed at step 6. If I = II selector 5 should be picked up. The plugboard wiring necessary to accomplish this is as follows:

Out of I = II BRANCH to PROGRAM IN of a PROGRAM SELECT	Establishes the condition upon which the program variation is to occur and initiates the picking up of the selector.
POWER OUT of the PROGRAM SELECT to the specified SELECTOR PICKUP	The initiating pulse is converted to power sufficient to pick up a selector and is routed to the desired selector pickup.
DELAY OUT of the PROGRAM SELECT to the IN of the next STEP	Since it requires approximately 5-10 milliseconds to pick up the selector, the step pulse, which is required to initiate the next step, is delayed for 10 milliseconds to allow the selector to "pick up" before the next step begins (since the selector may affect the next step).
OUT of I > II of BRANCH to COMPUTER ALERT HUB 2	Stops the collation program and sets the sort-collate unit's pseudo demand station (MTU I) to "Ready". Activates HSCL Y.
COMPUTER-to-I/O CONTROL LINE to RESUME IN	Returns control to sort-collate unit in preparation for resuming collation program.
RESUME OUT to IN of next STEP	Synchronizes the pulses required to initiate next step with completion of the instructions given to the tape units by the computer.



SPECIAL CONDITIONS

End of File

The EF hub emits a pulse for MTU I, MTU II or MTU III at the time the end of file sentinel is detected for the appropriate tape unit. These hubs should always be wired to the terminal selects. Please refer to the topic on Terminal Selects in this chapter for a wiring example.

End of Data

This hub operates exactly like the end of file condition.

End of Count

The EC hub emits a pulse for MTU III and MTU IV when the end of count condition is detected on the appropriate tape unit. These hubs should always be wired to the terminal selects.

MISCELLANEOUS

Pulse Out Expander

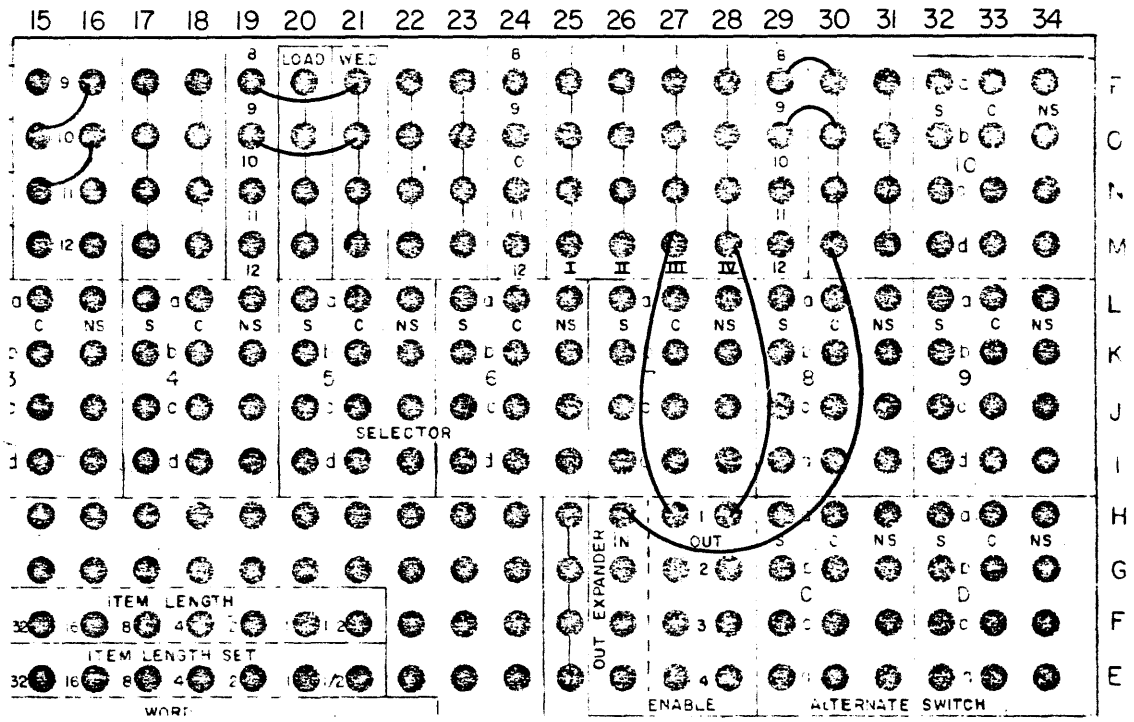
A pulse can be split three ways. If four or more paths of current are needed, the pulse must be amplified. One "in" produces two amplified "outs". These outs are diode protected, and allow current to flow only in one direction, thus no "backfeed" is possible.

Enable Out Expander

Enables requiring isolation are wired to the "in" of the enable out expander. One "in" produces two amplified "outs". These outs are diode protected.

Please refer to the topic on WED-Write End of Data in this chapter. Note that both step 8 and step 9 have MTU III and MTU IV as destinations. The hubs labeled I II III IV are bussed enables. Thus if any other step has its destination (or source) wired to MTU III, it backfeeds through the bus, and therefore also uses MTU IV as a destination (or source).

The wiring diagram illustrates WED on MTU III and MTU IV where 1/2 blockette item size is used, and where isolation of MTU III and MTU IV is necessary.



Buses

Bus hubs facilitate wiring multiple ins or outs which do not require isolation.

Unibuses

Unibuses are used if it is "necessary" that any one of four diode protected "ins" provide one diode protected "out".

COMPUTER ALERT OPERATIONS IN THE CENTRAL COMPUTER

Although central computer coding is not a part of this manual, it is presented here to supplement the discussion of Computer Alert in this chapter and to fill out the complete picture of computer alert operations.

Even though computer alert operations are anticipated, the computer can be involved in a totally unrelated program as long as it tests the status of MTU I (the sort-collate unit's pseudo demand station) periodically. When the Sort-Collate System has control of the tape units, each Demand Test In of MTU I performed by the computer results in a NOT READY signal from sort-collate control. After a computer alert operation is initiated, the Demand Test In of MTU I results in a READY signal.

Upon finding a READY signal, the computer program carries out a Demand In sequence specifying MTU I. This Demand In sequence actually occurs in the sort-collate unit, not (as programmed) in MTU I. As a result of this Demand In sequence the following events occur:

1. A SPECIAL OUT is generated for MTU I, and

2. The specified high speed control lines (HSCL) are activated. The HSCL are W, X, Y and Z which carry a value of 8, 4, 2 and 1 respectively. The HSCL that are activated correspond in value to the same numbered computer alert hubs that are activated. The impulsing of these CA hubs sets high speed I/O to computer control line storage. Figure 8 demonstrates the Relation Between CA Hubs and HSCL.

Sort-Collate Computer Alert Hubs	HSCL W X Y Z 8 4 2 1	Sort-Collate Computer Alert Hubs	HSCL W X Y Z 8 4 2 1
1	0 0 0 1	9	1 0 0 1
2	0 0 1 0	10	1 0 1 0
3	0 0 1 1	11	1 0 1 1
4	0 1 0 0	12	1 1 0 0
5	0 1 0 1	13	1 1 0 1
6	0 1 1 0	14	1 1 1 0
7	0 1 1 1	15	1 1 1 1
8	1 0 0 0		

Figure 8. Relation between CA Hubs and HSCL

Upon obtaining a SPECIAL OUT, the computer program must test the high speed input-output to computer control line storage, to determine which lines are activated, and then transfer control to the subroutine requiring execution. At this point the control of the four tape units is turned over to the computer, and they can be independently demanded and given regular tape unit commands.

When the computer has completed the specified subroutine, it can be programmed to

1. demand any MTU to give it an instruction and demand the tape unit (again) to pulse one of the computer to input-output lines (E-I) to revert subsequent control of all tape units to the sort-collate control (if the plugboard is used this can be done simultaneously), or

2. demand the unit to pulse the computer to input-output control line to revert control back to the sort-collate unit without giving a tape instruction. (If the plugboard is used, the control line can be impulsed without demanding the tape unit.)

In either case this initiates the transfer of tape unit control from the computer to the Sort-Collate System. In 1. it can also send up-dated data to one MTU. If other MTUs are to receive instructions, each must be separately demanded and given the instruction before the computer to input-output control line is pulsed.

Assume the same example presented in the topic CA-Computer Alert where

1. if I > II CA1 is impulsed,

2. if I $\leq$ II CA2 is impulsed,

3. computer to I/O control line E is wired to resume in,

4. MTU I is on demand station 3 and,

5. MTU II is on demand station 4.

The computer program appears as follows:

Instr.	U	V	W	PR	Comments
200 ⋮ 300					Unrelated Program
301	030	302	200	34Δ	Demand Test In MTU I. If READY, take V - CA sequence. If NOT READY, take W-Unrelated Program.
302	030	555	303	45Δ	Demand MTU I. Must get SPECIAL OUT, so go to 303.
303	13Z	555	400	39Δ	Test HSCL for Z (CA 1). If Z, track switch and go to 400. If not Z proceed to 304.
304	13Y	555	450	39Δ	Test HSCL for Y (CA 2). If Y, track switch and go to 450. If not Y proceed to 305.
305	ERROR ROUTINE				Must be Z or Y.
400	Process Item				Z (CA 1) routine.
⋮					
447	131	564	305	45Δ	Demand MTU I and transfer track to buffer.
448	031	575	200	45Δ	Demand MTU I and impulse computer to I/O
449	992	992	200	41Δ	control line E.
450	Process Item				Y (CA 2) routine.
⋮					
487	141	564	305	45Δ	Demand MTU II and transfer track to buffer.
488	041	575	200	45Δ	Demand MTU II and impulse computer to I/O
489	992	992	200	41Δ	control line E.

In this mode, sentinel signals which may be plugged to pass from the MTU to the computer over input-output to computer HSCL (thus causing a SPECIAL OUT to result when the MTU is demanded) are also sent to the sort-collate control unit, where they appear as pulses at the appropriately labeled hubs on the sort-collate plugboard. These pulses are ordinarily wired to terminal selects, so that the condition is remembered in a selector when the sort-collate again assumes control. The implications of this are that no instruction, which affects more than one item, should be given to any one MTU during a computer alert.

Remington Rand Univac
DIVISION OF SPERRY RAND CORPORATION

UNIVAC FILE — COMPUTER SYSTEM — SORT COLLATE UNIT

PROGRAM AND FUNCTION CONTROL CHART

APPLICATION _____

PROGRAM NO : _____

STEP NO.	STEP IN FROM	SOURCE		PR	DESTINATION		STEP OUT TO
		S	DESCRIPTION		D	DESCRIPTION	
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							

START TO

BRANCHING				
NO.	IN FROM STEP	TO IF >	TO IF =	TO IF <
1				
2				
3				
4				
5				
6				
7				
8				
9				

COMPUTER ALERT	
NO.	FROM
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	

ITEM LENGTH			
NUMBER OF BLOCKETTES=			
LENGTH TO		SET FROM	
½		½	
1		1	
2		2	
4		4	
8		8	
16		16	
32		32	
64		64	

COMPARE POSITIONS	
HUB	FROM / TO
W BEG FROM	
C BEG FROM	
W END TO	
C END TO	
W BEG FROM	
C BEG FROM	
W END TO	
C END TO	
W BEG FROM	
C BEG FROM	
W END TO	
C END TO	
W BEG FROM	
C BEG FROM	
W END TO	
C END TO	

PULSE OUT EXPANDERS			
NO.	IN FROM	OUT TO	OUT TO
1			
2			
3			
4			

WIND	
HUB	IN FROM
I	
II	
III	
IV	

RESUME	
HUB	FROM / TO
IN	
OUT	

TERMINAL CONDITION	
HUB	TO
EC III	
EC IV	
ED I	
ED II	
ED III	
EF I	
EF II	
EF III	

ENABLE OUT EXPANDERS			
NO.	IN FROM	OUT TO	OUT TO
1			
2			
3			
4			

REWIND	
HUB	IN FROM / OUT TO
I	
II	
III	
IV	
ALL	
OUT	

COMPUTER TO I/O LINES	
NO.	TO
E	
F	
G	
H	
I	

I/O TO COMPUTER LINES	
NO.	FROM
h	
i	
j	
k	

COMPARE MODE III	
HUB	TO / FROM
OUT	
III	

Remington Rand Univac
DIVISION OF SPERRY RAND CORPORATION

UNIVAC FILE – COMPUTER SYSTEM – SORT COLLATE UNIT

SELECTOR CONTROL CHART

APPLICATION : _____

PROGRAM NO : _____

SELECTORS									
PICK UP FROM	NO	SELECT	COMMON	NON-SELECT	PICK UP FROM	NO	SELECT	COMMON	NON-SELECT
	1a					7a			
	1b					7b			
	1c					7c			
	1d					7d			
	2a					8a			
	2b					8b			
	2c					8c			
	2d					8d			
	3a					9a			
	3b					9b			
	3c					9c			
	3d					9d			
	4a					10a			
	4b					10b			
	4c					10c			
	4d					10d			
	5a					11a			
	5b					11b			
	5c					11c			
	5d					11d			
	6a					12a			
	6b					12b			
	6c					12c			
	6d					12d			

PROGRAM SELECTS				
PS NO.	IN FROM	DELAY OUT TO	DROP OUT FROM	POWER OUT TO
1				
2				
3				
4				
5				
6				

TERMINAL PROGRAM SELECTS			
PS NO.	IN FROM	DROP OUT FROM	POWER OUT TO
7			
8			
9			
10			
11			
12			
13			

SELECTOR PICK UP			
NO.	IN FROM	NO.	IN FROM
1		7	
2		8	
3		9	
4		10	
5		11	
6		12	

ALTERNATE SWITCHES									
SWITCH SET	NO.	SELECT	COMMON	NON-SELECT	SWITCH SET	NO	SELECT	COMMON	NON-SELECT
	Aa					Ca			
	Ab					Cb			
	Ac					Cc			
	Ad					Cd			
	Ba					Da			
	Bb					Db			
	Bc					Dc			
	Bd					Dd			

Chapter V

TIMING ESTIMATES FOR THE SORT-COLLATE SYSTEM

Timing, for all Sort-Collate System operations consists primarily of reel mounting time, running time and rewind time. Timing estimates for each operation are discussed below.

SEQUENCE CHECKING

Sequence checking involves mounting the tape to be checked on MTU I, mounting blank reels of tape on MTU II, MTU III and MTU IV, running time and rewind time. The following example illustrates the time estimates for a full reel of tape for either 1/2" or 1" blockette spacing. Assume blank reels of tape have previously been mounted on the proper magnetic tape units.

	1/2" 20,000 Blockettes	1" 14,100 Blockettes
1. Mounting Input Reel	.5 minutes	.5 minutes
2. Running Time	9.5 minutes	8.9 minutes
3. Rewind Time	6.0 minutes	6.6 minutes
Total	16.0 minutes	16.0 minutes

To obtain a time estimate for a partial reel only a few calculations are required. Running time is obtained by multiplying the blockette handling by the number of blockettes. Rewind time is obtained by multiplying the blockette length by the number of blockettes and dividing the result by the tape transport speed.

	Blockette Handling Time	Blockette Length Including Spacing	Tape Transport Speed
1/2"	28.5 milli-seconds	1.36 inches	75" second
1" (average of 6 blockettes)	37.8 milli-seconds	2.09 inches	75" second

In the Univac I and II mode, 1" spacing is used after the first 5 blockettes and 2.4" are used after the 6th blockette. Thus the blockette handling time is 34.5 milliseconds for the first 5 blockettes and 54 milliseconds for the 6th blockette yielding an average of 37.8 ms. The blockette is 0.86", the spacing is 1" and 2.4" as described above. The average total length is 2.09 inches.

The time for sequence checking 10,000 blockettes at 1/2" blockette spacing is illustrated

Mounting			.5 minutes
Running	$\frac{28.5 \times 10{,}000}{1{,}000 \times 60}$	=	4.75 minutes
Rewind	$\frac{1.36 \times 10{,}000}{75 \times 60}$	=	3.0 minutes
Total			8.25 minutes

SORTING

Sort operations also involve mounting, running and rewind time as previously noted. However, as sorting operations require a number of passes through the tape data, the running time must be calculated to include all passes.

The running time required for sorting depends on the number of items to be sorted, the length of the items to be sorted, and the number of natural sequences already in the items. Usually the number and the length of the items to be sorted can be accurately determined rather easily. However, the number of natural sequences already in the items is sometimes impossible to determine. For practical purposes, if the number of sequences is unknown, the worst possible situation can be assumed. This would be a case where the number of sequences equals the number of items. The calculation of running time for this case is listed below:

1. Calculate total number of passes,
2. Calculate number of blockettes read in one pass,
3. Calculate time for one pass by multiplying 2. by the blockette handling time.
4. Calculate total time for sorting by multiplying 1. by 3., and
5. Add tape mounting and rewind time to sorting time.

The above illustrates the general principles of the sorting formula used to compute Table 4 (Sorting Timing Chart). Only the mounting time of .5 minutes per reel need be added to obtain total time.

Number of Items	Item Size - 1 Blockette						Item Size - 2 Blockettes						Item Size - 5 Blockettes						Item Size - 10 Blockettes					
	1/2" Spacing			1" Spacing			1/2" Spacing			1" Spacing			1/2" Spacing			1" Spacing			1/2" Spacing			1" Spacing		
	Sort.	Total (2) Rewind	Total Min.	Sort.	Total (2) Rewind	Total Min.	Sort.	Total (2) Rewind	Total Min.	Sort.	Total (2) Rewind	Total Min.	Sort.	Total (2) Rewind	Total Min.	Sort.	Total (2) Rewind	Total Min.	Sort.	Total (2) Rewind	Total Min.	Sort.	Total (2) Rewind	Total Min.
250	1.1	.2	1.3	1.4	.2	1.6	2.1	.3	2.4	2.8	.5	3.3	5.3	.8	6.1	7.1	1.2	8.3	10.7	1.5	12.2	14.2	2.3	16.5
500	2.6	.3	2.9	3.5	.5	4.0	5.2	.6	5.8	6.9	.9	7.8	13.1	1.5	14.6	17.3	2.3	19.6	26.1	3.0	29.1	34.7	4.6	39.3
750	3.9	.5	4.4	5.2	.7	5.9	7.8	.9	8.7	10.4	1.4	11.8	19.6	2.3	21.9	26.0	3.5	29.5	39.2	4.5	43.7	52.0	7.0	59.0
1,000	5.2	.6	5.8	6.9	.9	7.8	10.5	1.2	11.7	13.9	1.9	15.8	26.1	3.0	29.1	34.7	4.6	39.3	52.3	6.0	58.3	69.3 (1,410 items)	9.3	78.6
2,000	12.4	1.2	13.6	16.4	1.9	18.3	24.7	2.4	27.1	32.8	3.7	36.5	61.8	6.0	67.8	81.9 (2820 items)	9.3	91.2	123.5	12.1	135.6	115.5	13.1	128.6
3,000	18.5	1.8	20.3	24.6	2.8	27.4	37.1	3.6	40.7	49.1	5.6	54.7	92.6	9.1	101.7	115.5	13.1	128.6	-	-	-	-	-	-
4,000	24.7	2.4	27.1	32.8	3.7	36.5	49.4	4.8	54.2	65.5	7.4	72.9	123.5	12.1	135.6	-	-	-	-	-	-	-	-	-
5,000	35.6	3.0	38.6	47.3	4.6	51.9	71.3	6.0	77.3	94.5 (7050 Items)	9.3	103.8	-	-	-	-	-	-	-	-	-	-	-	-
7,500	53.4	4.5	57.9	70.9	7.0	77.9	106.9	9.1	116.0	133.2	13.1	146.3	-	-	-	-	-	-	-	-	-	-	-	-
10,000	71.3	6.0	77.3	94.5	9.3	103.8	142.5	12.1	154.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12,500	89.1	7.6	96.7	118.1	11.6	129.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
14,100	100.5	8.5	109.0	133.2	13.1	146.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
15,000	106.9	9.1	116.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
17,500	141.3	10.6	151.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20,000	161.5	12.1	173.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 4. Sorting Timing Chart*

*Assuming Worst Possible Case of Sequence of Blockettes.

The detailed method for computing sorting time estimates is given below so as to enable calculation of time estimates for an item size or number of items not listed in the table. Again, assume the number of sequences equals the number of items. The method is:

Calculate total number passes, ΣP.

1) One pass of each item is required for the initial dispersion run (this is the preliminary sequence checking operation).

2) The maximum number of sorting passes per item is represented by P in the formula

$$2^P = I$$

where I is the number of items to be sorted and P is the power of 2 which yields a value equal to or greater than I.

3) Add one more pass if P is computed in (2) above, is odd. Thus the total number of passes (ΣP) for each item is the total of (1), (2), and (3) above.

Calculate number of blockettes read in one pass, ΣN.

1) Multiply number of items (I) by the number of blockettes per item to find the total number of blockettes read in one pass of the data. Thus

$$I \times N = \Sigma N$$

Calculate time estimate for one pass, TP

1) Multiply total number of blockettes (ΣN) read in one pass by the blockette handling time (BH).

$$TP = \Sigma N \times BH$$

where for one or more blockette size item:

the BH for 1/2" = 28.5 milliseconds
and BH for 1" = 37.8 milliseconds;

where for 1/2 blockette size item:

the BH for 1/2" = 40.0 milliseconds
and BH for 1" = 53.0 milliseconds

Calculate total time (T_s) for sorting

1) Multiply time estimate for one pass (TP) by number passes (ΣP)

$$T_s = TP \times \Sigma P$$

Add tape mounting and rewind time estimates.

$$T_t = T_s + M + 2R$$

1) Mounting is .5 minutes per reel

2) Rewind is computed as in sequence check, but note that there are two rewinds; one after the sequence check, and the second after the sort.

The complete formula can be expressed as:

$$T_t = \Sigma P ([I \times N] \times BH) + 2R + M$$

The following example illustrates the method. Assume a reel contains 1,000 items, ten blockettes per item, with 1/2" blockette spacing. The step by step solution is illustrated:

ΣP

1) Dispersion run 1

2) Sorting passes $P = 10$

$2^P \geq I$

$2^{10} \geq 1{,}000$

($2^9 = 512$; $2^{10} = 1{,}024$)

Therefore P = 10 since 2^{10} yields a value greater than 1,000 (I)

3) P is even so 1 is not added. - 0 -

$\Sigma P = 11$

ΣN

1) $\Sigma N = I \times N$ $I = 1{,}000$, $N = 10$

$\Sigma N = 10{,}000$

TP

1) $TP = \Sigma N \times BH$ $BH = 28.5ms$
TP = 4.75 minutes

T_S

1) $T_S = TP \times \Sigma P$
   $T_S = 52.3$ minutes

Add 2R & M

1) M = .5 (assume only input tape mounted in sequence check)
   1.0 (changing original master reel)
   1.5 minutes

2) 2R = 6.0 $\qquad \frac{10,000 \times 1.36}{75 \times 60} = 3.0$

Another method of computing the rewind time estimate is to multiply the number of blockettes by approximately 18 milliseconds for 1/2", or 28 milliseconds for 1" thus

$$\frac{10,000 \times 18}{60} = 3.0$$

3) $T_t = 59.8$ minutes

Table 5 (Table of Powers of Two) is included at this point for ease of reference in computing ΣP where $2^P = I$ must be determined.

P Item	P Item	P Item
$2^1 = 0$	$2^6 = 64$	$2^{11} = 2,048$
$2^2 = 4$	$2^7 = 128$	$2^{12} = 4,096$
$2^3 = 8$	$2^8 = 256$	$2^{13} = 8,192$
$2^4 = 16$	$2^9 = 512$	$2^{14} = 16,384$
$2^5 = 32$	$2^{10} = 1,024$	$2^{15} = 32,768$

Table 5. Table of Powers of Two

PROGRAM COLLATE OPERATIONS

Program collate operations involve the previously discussed mounting, running and rewind times and one additional factor; delays during computer alerts. It is convenient to separate collating operations into two categories; those programs in which the item will normally be read only once and those programs, in which several tape passes must be made such as merging programs.

Single Tape Pass Collation Program

1) Mounting Time

Mounting time is .5 minutes per reel or 1 minute to change reels.

2) Running Time

The running time is based on the number of blockettes to be read, multiplied by the blockette handling time (refer to topic on Sorting). The number of blockettes is easily determined in most cases where only a single reading is required, by using the following formula.

$$I \times N = \Sigma N$$

I is the number of items in all input files involved; N is the number of blockettes per item (note: if the item size varies between input files, they will have to be calculated separately first; and then combined), and ΣN is the total number of blockettes to be processed.

3) Rewind Time

The sort-collate unit cannot perform other functions while it is rewinding, since the system becomes interlocked upon initiation of the rewind process. However, all MTU's can be rewound at one time if the program is designed to take advantage of this feature.

Rewind occurs at tape speed of 75" second, and can be computed as follows:

$$R = \frac{\Sigma N \times \begin{cases} 1.36 \text{ for } 1/2" \\ 2.09 \text{ for } 1" \end{cases}}{75 \times 60}$$

where ΣN is the number of blockettes to be passed in the rewind process.

The tape speed, reduced to time per blockette, is:

18 milliseconds per blockette with 1/2" spacing
28 milliseconds per blockette with 1" spacing

thus the rewind time can also be computed as

$$R = \Sigma N \times \begin{cases} 18 \text{ for } 1/2" \\ 28 \text{ for } 1" \end{cases}$$

4) Delays During Computer Alerts

It is impractical to estimate delays during a computer alert operation and, since in most programs they comprise an insignificant part of the total time, they are not considered here.

Multiple Tape Pass Collation Program

A multiple tape pass collation program usually involves increased mounting, running and rewind times as well as delays during computer alert. Mounting and rewind times can be computed and minimized following the principles discussed previously. Running times are discussed below.

A merging program, involving more than 3 reels of unsorted data pertaining to one file, is an excellent example of a program requiring several tape passes through the data.

As a reel must be sorted for merging operations, the reels are initially sorted into sequence. The individual reels are then merged, forming "strings" of reels in sequence; the "strings" are then merged, forming larger strings, etc., until there is one "string" of reels with the data in sequence from the beginning of the first reel through the end of the last reel. In this operation each item is read many times.

The object in merging programs is to keep the number of tape passes to a minimum. The straightforward approach is not necessarily the one that accomplishes this purpose. For example, consider the merging of 12 reels with a maximum of 3 magnetic tape input units. The straightforward approach is to do four 3-way merges producing four ordered strings of 3 reels each. Three of these strings are then merged to form a string of 9 reels which is then merged with the remaining 3 reel string to produce the final 12 reel string. In all, 33 tape passes are required. This approach is illustrated in Figure 9, Straightforward Approach to 12 Reel Merge.

However by merging the 12 reels in the manner illustrated in Figure 10, Algorithm Approach to 12 Reel Merge, only 29 tape passes are involved. Two steps are required to calculate the exact number of passes. These steps are:

1. An algorithm provides the maximum and minimum number of passes for any one reel as well as the maximum and minimum total passes for all reels, i.e., the limits.

2. A refinement, based on the algorithm, determines the exact number of passes which falls between the algorithm's limits.

The algorithm is expressed as follows:

$$TU^{n-1} \leq R \leq TU^{n}$$

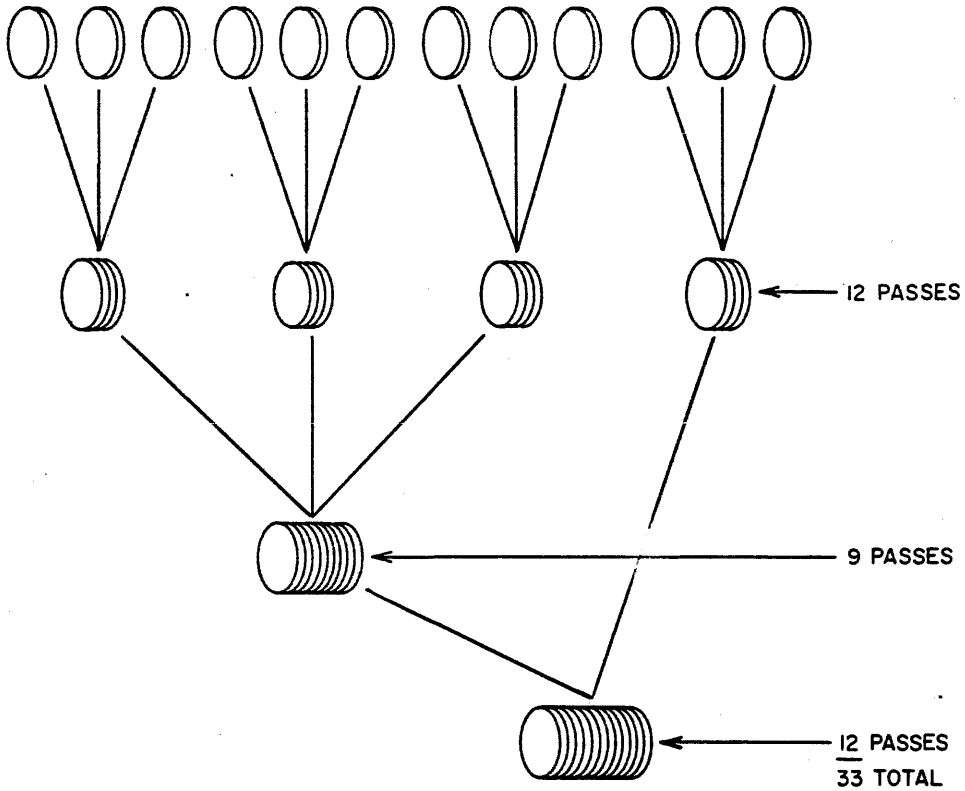


Figure 9. Straightforward Approach to 12 Reel Merge

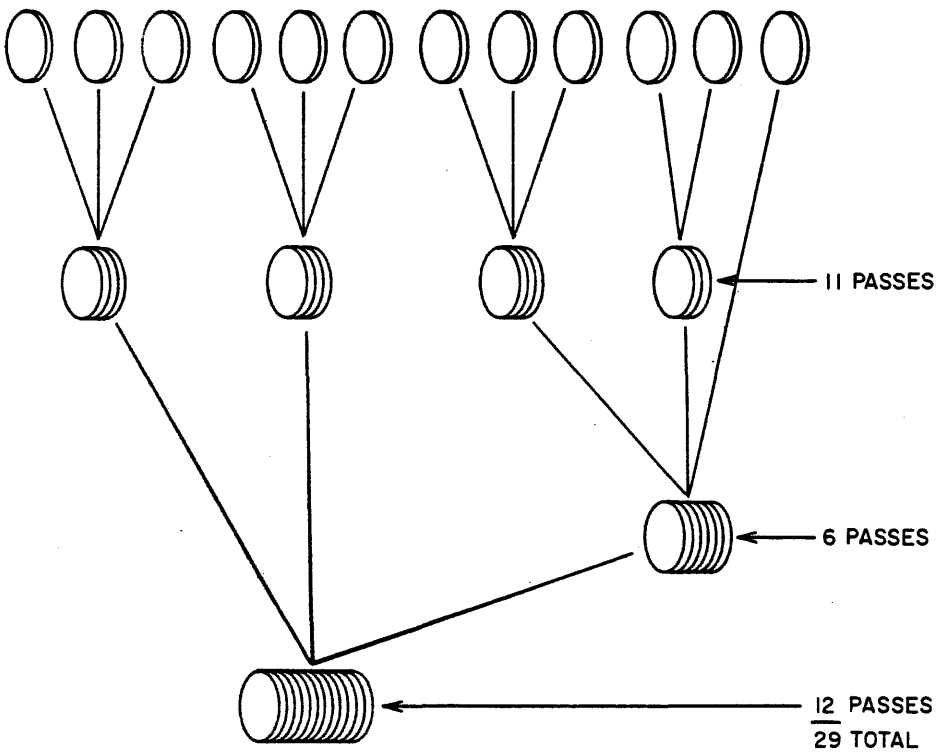


Figure 10. Algorithm Approach to 12 Reel Merge

where (1) TU = number of input tape units,
(2) R = number of reels to be merged,
(3) n-1 = minimum number of passes for any one reel,
(4) n = maximum number of passes for any one reel.
(5) n-1 x R = minimum total number of tape passes for all reels
(6) n x R = maximum total number of tape passes for all reels.

As an example, consider the problem presented in Figure 9, where 12 reels are to be merged using 3 input tape units. Then

(1) $Tu^{n-1} \leq R \leq TU^{n}$

(2) $3^2 \leq 12 \leq 3^3$

(3) $9 \leq 12 \leq 27$

By inspection, n must be 3 since $3^{n-1} = 3^2 = 9$ which is less than 12, and 12 is less than $3^n = 3^3 = 27$

(4) n-1 = 2 = minimum number of times that any one reel is passed

(5) n = 3 = maximum number of times that any one reel is passed

(6) n-1 x R = 2 x 12 = 24 = minimum total number of tape passes

(7) n x R = 3 x 12 = 36 = maximum total number of tape passes.

From Figure 10, it can be seen that the first six reels, and the last reel are passed the minimum number of times (2), and reels 7-11 are passed the maximum number of times (3). Further, the limits of total tape passes are 24 and 36.

The refinement, which is used to obtain the exact number of passes within the limits of 24 and 36, works from the final merge, i.e., the merge that results in one "string" (of 12 reels) backwards to the starting point where 12 individual sorted reels were ready to be merged. The method is as follows:

1. Start with the final merge where the result is a string of 12 reels. Thus for this pass R = 12. Calculate the length of the strings assigned to each input tape unit for the final merge; i.e., how many reels (a string in themselves) will be mounted on MTU I, MTU II and MTU III. Obviously, 12 reels must be assigned to produce a 12 reel string.

   a) As the maximum number of passes for any one reel is n and the minimum number of passes is n-1, then starting the final merge every reel will have already been run one less than the minimum or TU^{n-2}.

Thus starting final merge assign a minimum of $3^{n-2} = 3^1 = 3$ reels to every MTU.

MTU I	MTU II	MTU III	
3 reels	3 reels	3 reels	9 reels assigned
			3 reels unassigned
			12 reels total

b) Attempt to build as many MTUs as possible up to a maximum string of TU^{n-1} for each reel using the unassigned reels. Thus

$3^2 = 9$ is maximum string for <u>each</u> reel. As the number of unassigned reels plus assigned reels per MTU is (equal to or) less than 9, assign the 3 unassigned reels to MTU I. Thus the starting configuration for the final merge is

MTU I	MTU II	MTU III	
6	3	3	12 reels total

2. Repeat the same analysis for each of the resulting strings except that:

a) R now is the number of reels as computed in (1 b) above.

Thus R = 6 for MTU I
R = 3 for MTU II
R = 3 for MTU III

Thus for R = 6

$$TU^{n-1} \leq R \leq TU^n$$

$$3^1 \leq 6 \leq 3^2$$

$$3 \leq 6 \leq 9 \quad \text{so } n = 2$$

and for R = 3

$$TU^{n-1} \leq R \leq TU^n$$

$$3^1 \leq 3 \leq 3^1$$

$$3 \leq 3 \leq 3 \quad \text{so } n = 1$$

b) If $TU^n = 3$ then the configuration is obvious. Thus in (2 a) only the string of 6 reels needs to be further analyzed.

c) Proceed by assigning the minimum $TU^{n-2} = 3^{2-2} = 3^0 = 1$

MTU I	MTU II	MTU III	
1	1	1	3 reels assigned
			3 reels unassigned
			6 reels total

d) Build to maximum string $TU^{n-1} = 3^{2-1} = 3^1 = 3$ with unassigned reels (3). Thus 2 reels are added to MTU I to obtain maximum string and the last reel is assigned to MTU II.

MTU I	MTU II	MTU III	
3	2	1	6 reels total

Thus each string has been analyzed.

Table 6, a Merging Tape Assignment Chart for 3-Way Input is based on this algorithm and is presented here as an aid to obtaining efficient merging programs.

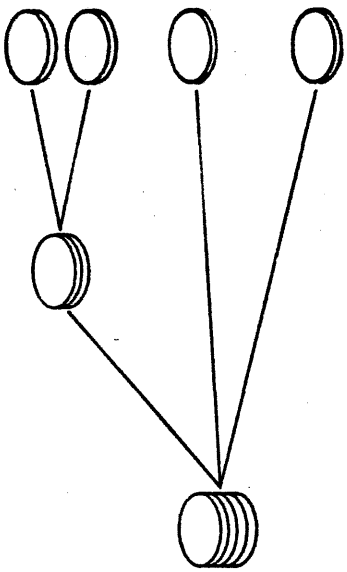
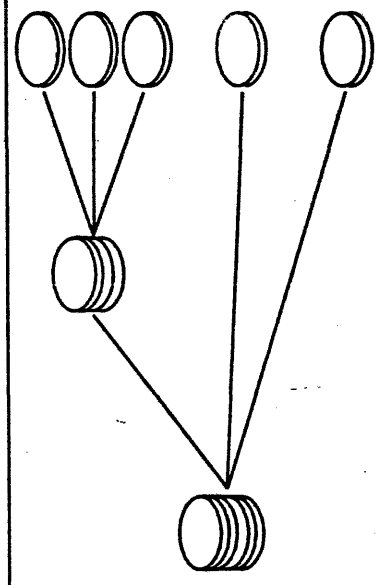
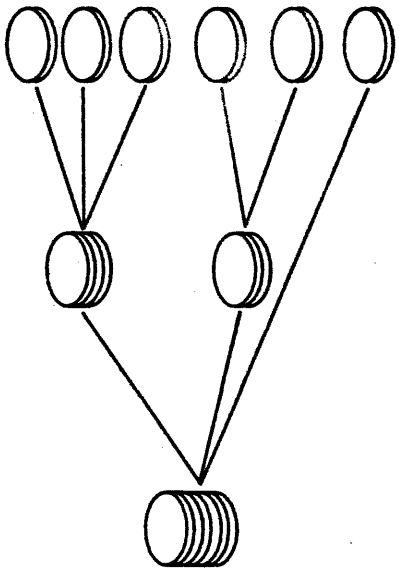
4 Reels			5 Reels			6 Reels		
MTU I	MTU II	MTU III	MTU I	MTU II	MTU III	MTU I	MTU II	MTU III
2	1	1	3	1	1	3	2	1
								
Number of Passes = 6			Number of Passes = 8			Number of Passes = 11		

Table 6. Merging Tape Assignment Chart for 3-Way Input

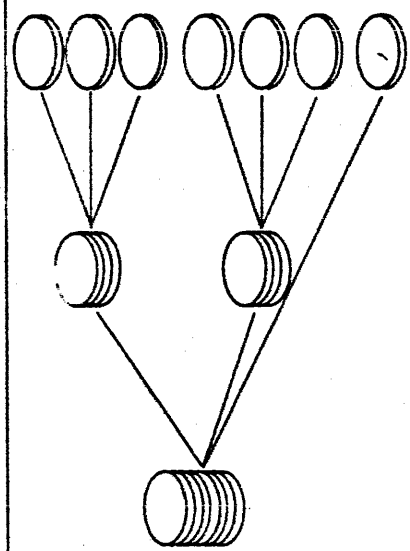
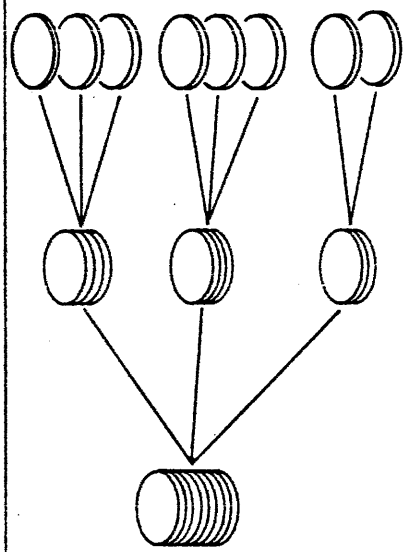
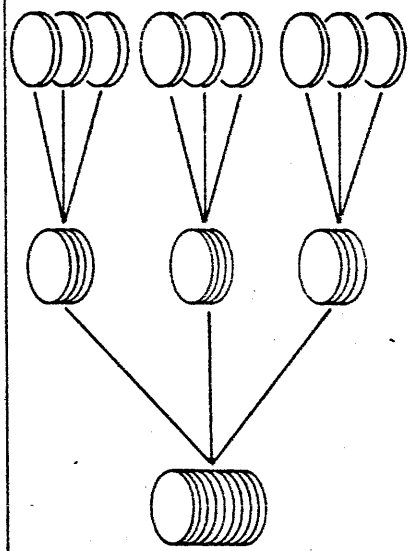
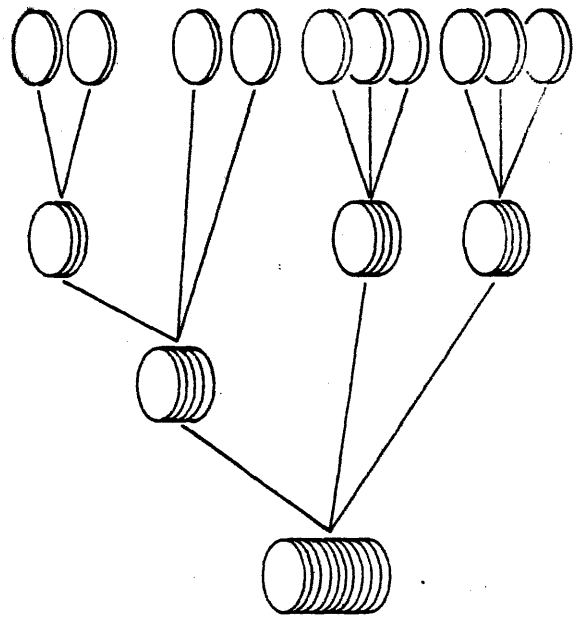
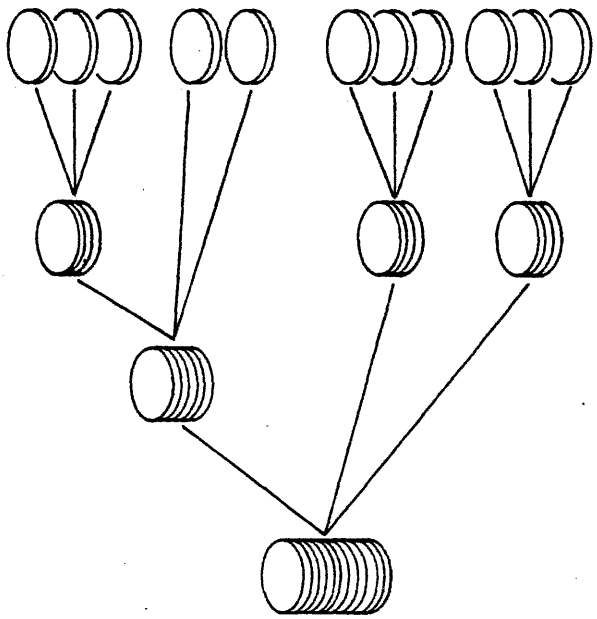
7 Reels			8 Reels			9 Reels		
MTU I	MTU II	MTU III	MTU I	MTU II	MTU III	MTU I	MTU II	MTU III
3	3	1	3	3	2	3	3	3
								
Number of Passes = 13			Number of Passes = 16			Number of Passes = 18		

Table 6A

10 Reels				11 Reels			
MTU I		MTU II	MTU III	MTU I		MTU II	MTU III
4		3	3	5		3	3
MTU I	MTU II	MTU III		MTU I	MTU II	MTU III	
2	1	1		3	1	1	



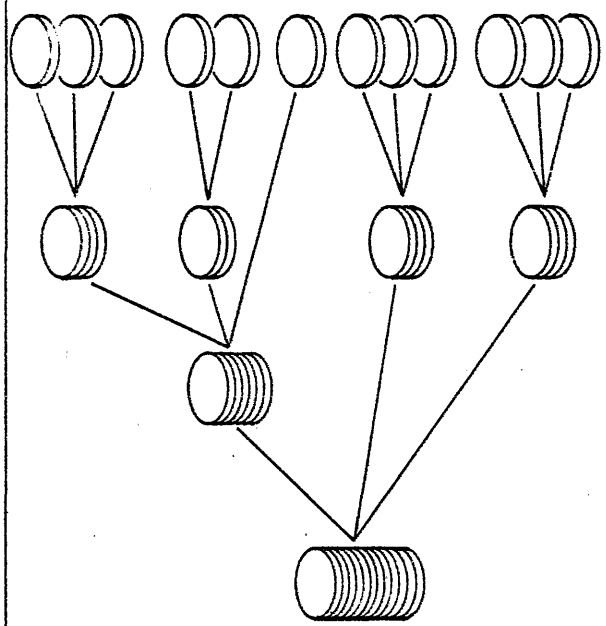


Number of Passes = 22

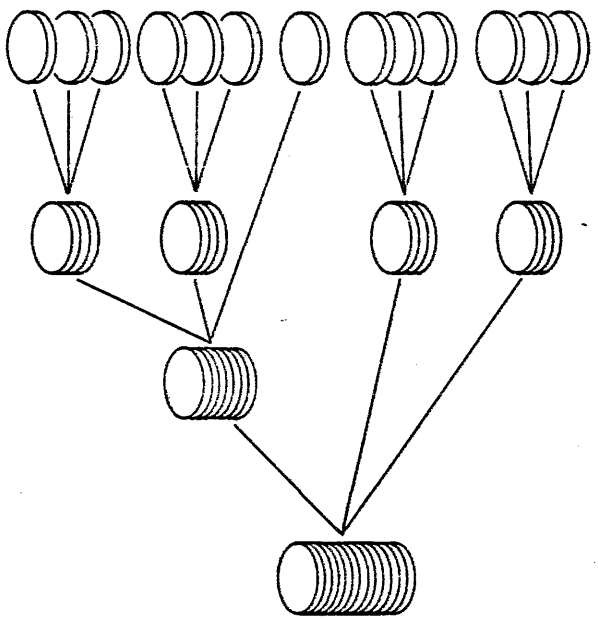
Number of Passes = 25

Table 6B

12 Reels					13 Reels				
MTU I			MTU II	MTU III	MTU I			MTU II	MTU III
6			3	3	7			3	3
MTU I	MTU II	MTU III			MTU I	MTU II	MTU III		
3	2	1			3	3	1		



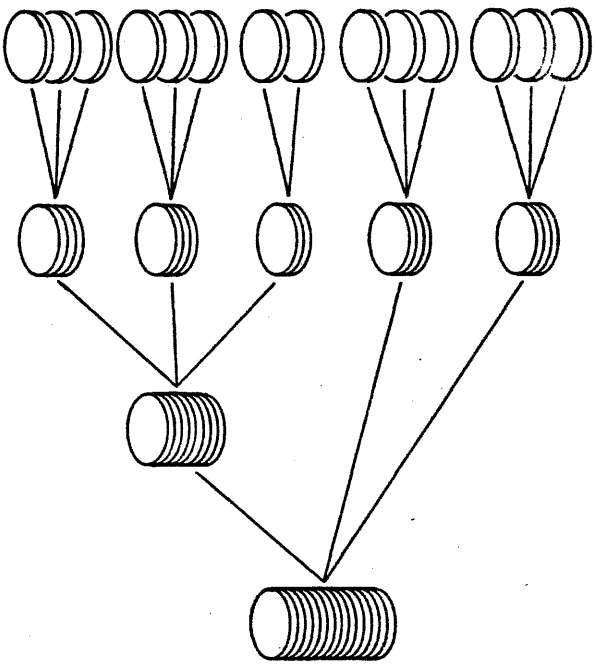
Number of Passes = 29

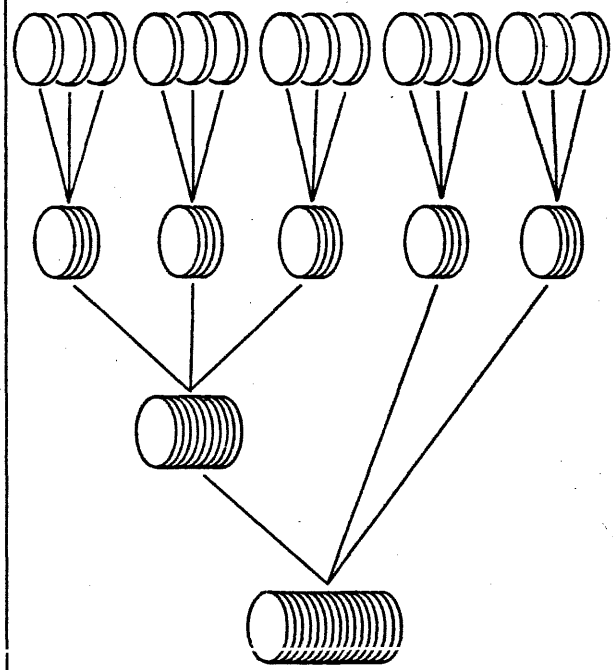


Number of Passes = 32

Table 6C

14 Reels					15 Reels				
MTU I			MTU II	MTU III	MTU I			MTU II	MTU III
8			3	3	9			3	3
MTU I	MTU II	MTU III			MTU I	MTU II	MTU III		
3	3	2			3	3	3		



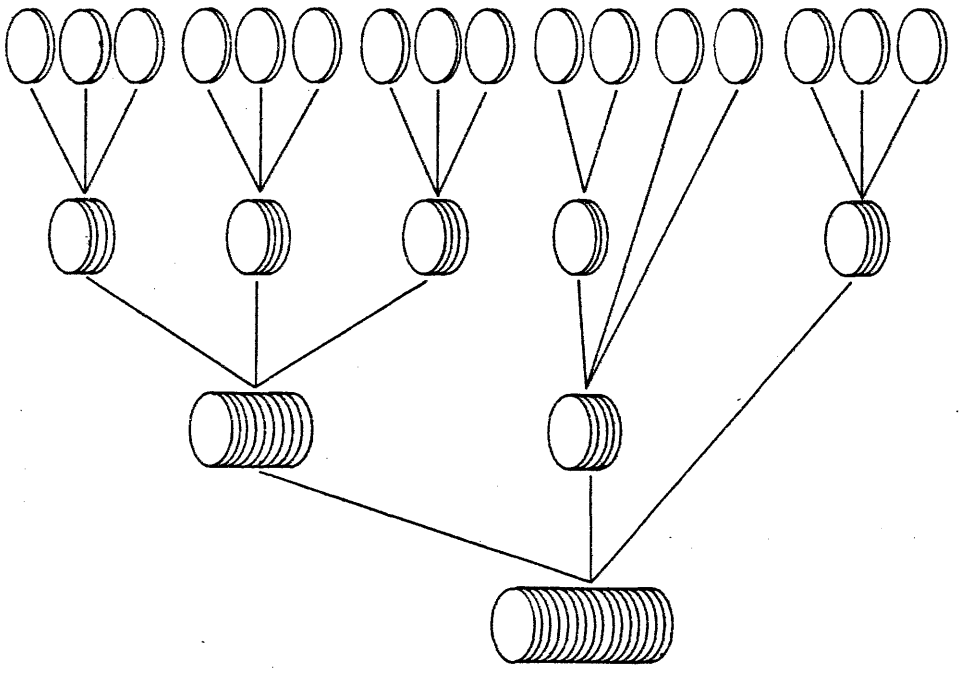


Number of Passes = 36

Number of Passes = 39

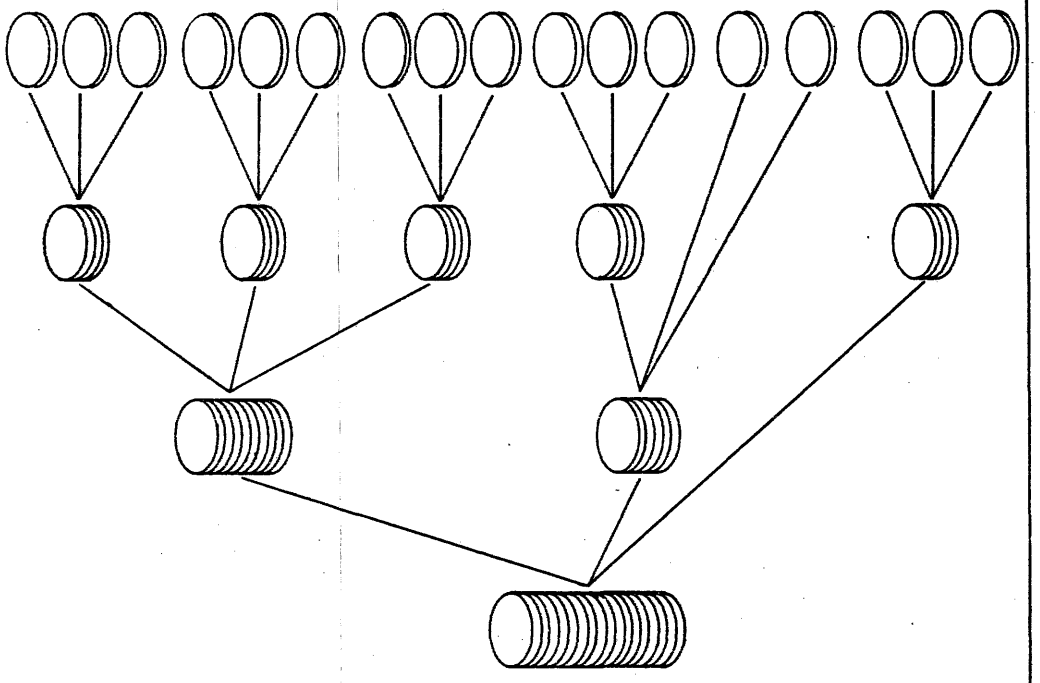
Table 6D

16 Reels						
MTU I			MTU II			MTU III
9			4			3
MTU I	MTU II	MTU III	MTU I	MTU II	MTU III	
3	3	3	2	1	1	



Number of Passes = 43

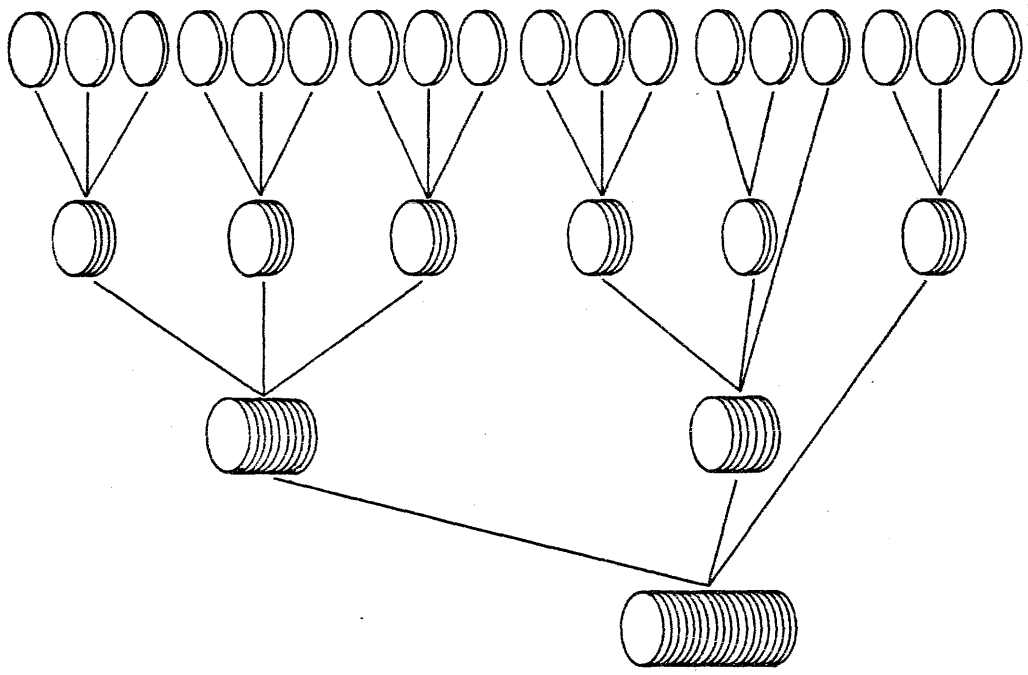
17 Reels						
MTU I			MTU II			MTU III
9			5			3
MTU I	MTU II	MTU III	MTU I	MTU II	MTU III	
3	3	3	3	1	1	



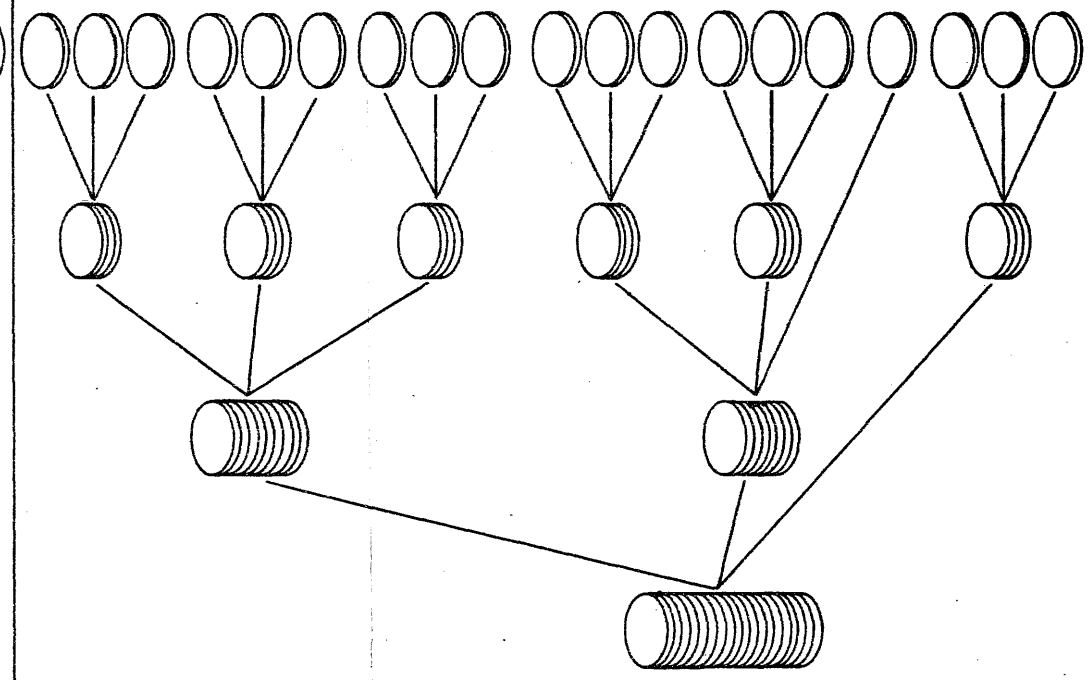
Number of Passes = 46

Table 6E

18 Reels							19 Reels						
MTU I			MTU II			MTU III	MTU I			MTU II			MTU III
9			6			3	9			7			3
MTU I	MTU II	MTU III	MTU I	MTU II	MTU III		MTU I	MTU II	MTU III	MTU I	MTU II	MTU III	
3	3	3	3	2	1		3	3	3	3	3	1	



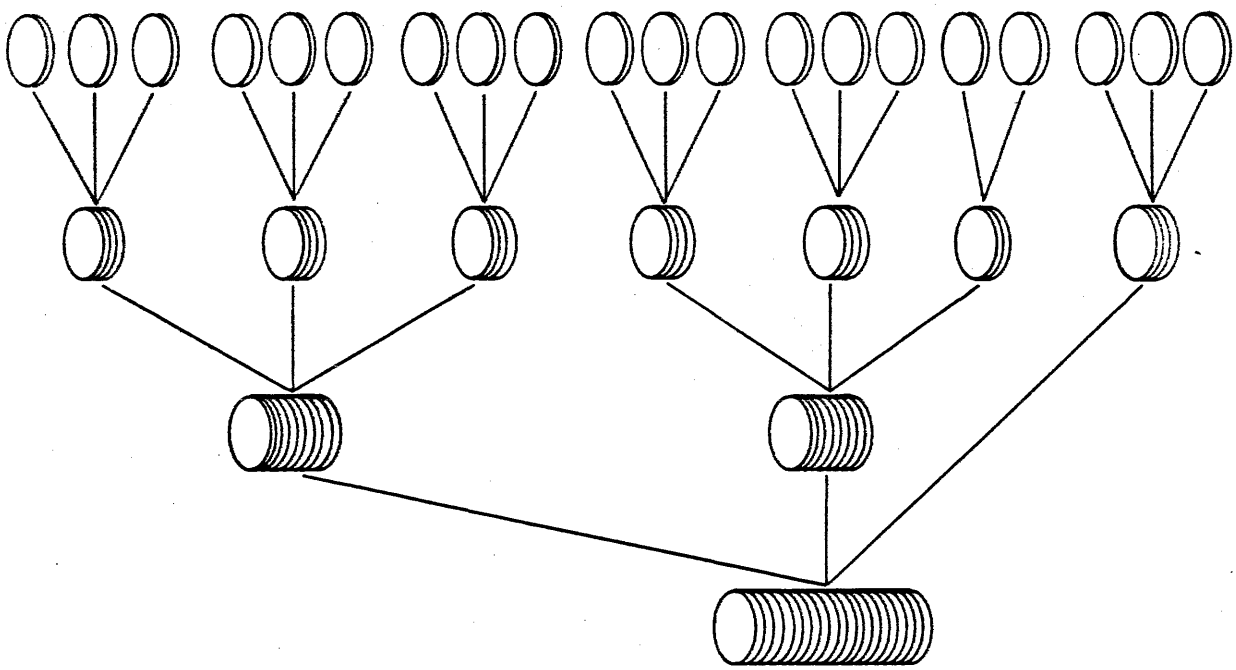
Number of Passes = 50



Number of Passes = 53

Table 6F

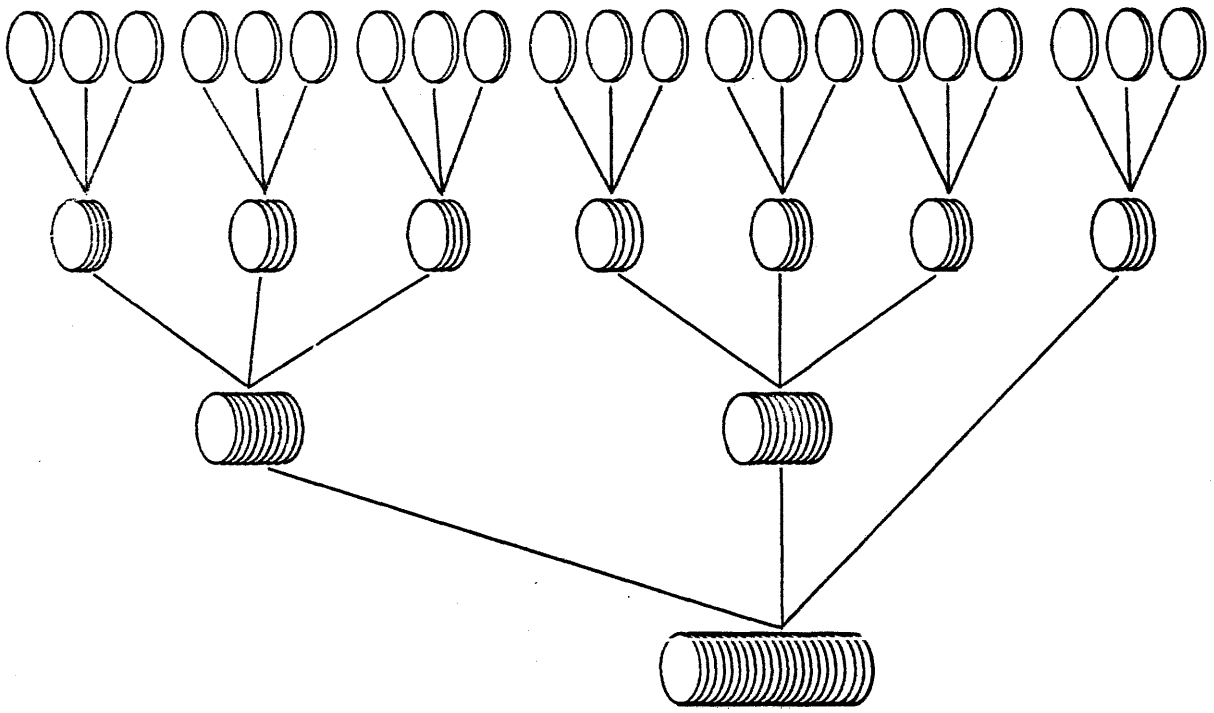
20 Reels						
MTU I			MTU II			MTU III
9			8			3
MTU I	MTU II	MTU III	MTU I	MTU II	MTU III	
3	3	3	3	3	2	



Number of Passes = 57

Table 6G

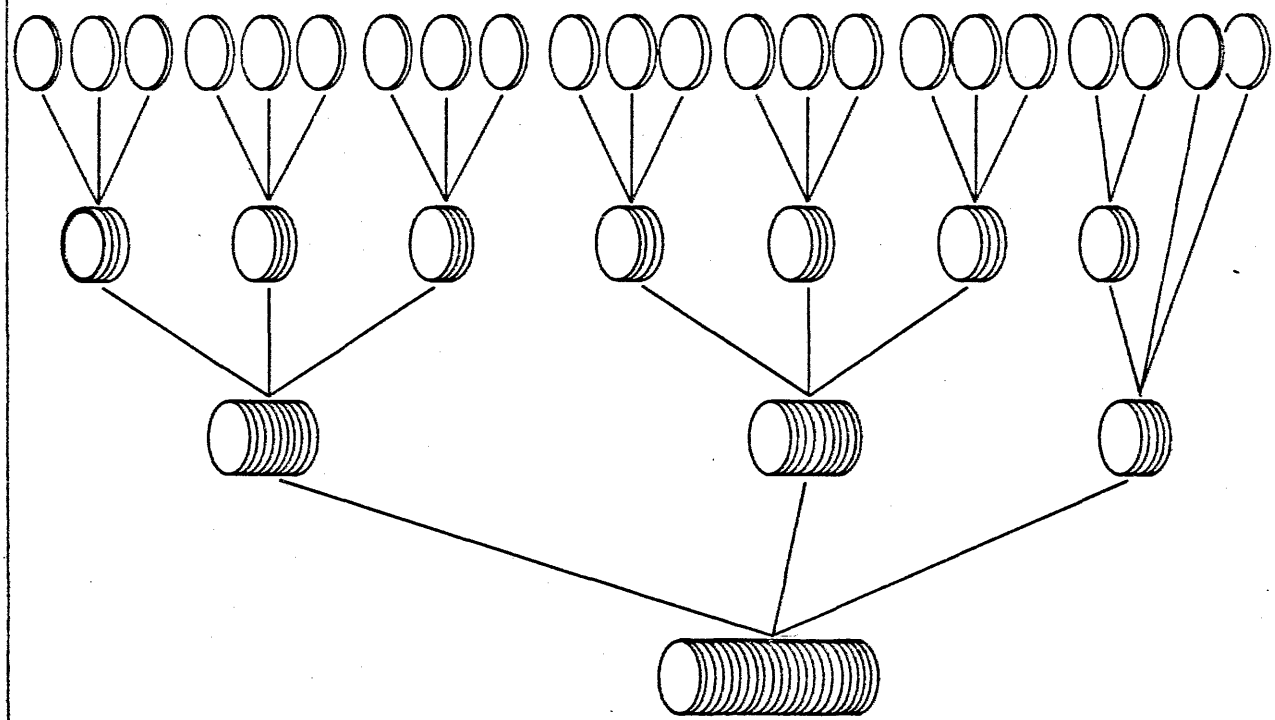
21 Reels					
MTU I			MTU II		MTU III
9			9		3
MTU I	MTU II	MTU III	MTU I	MTU II	MTU III
3	3	3	3	3	3



Number of Passes = 60

Table 6H

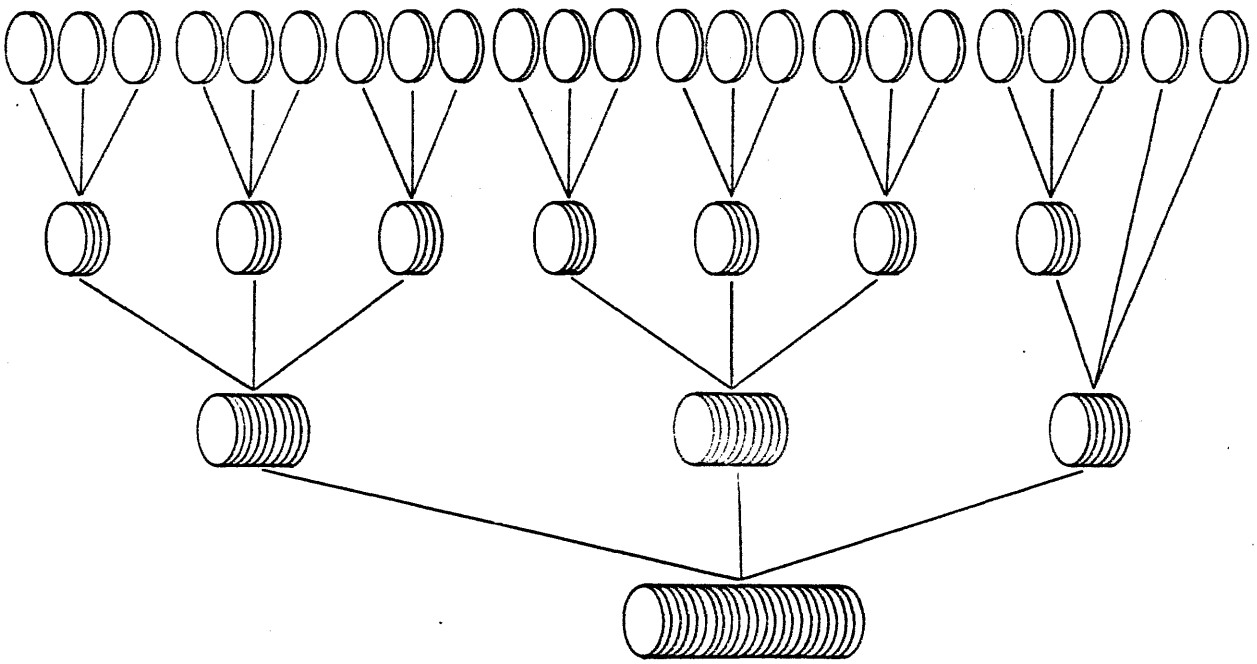
22 Reels								
MTU I			MTU II			MTU III		
9			9			4		
MTU I	MTU II	MTU III	MTU I	MTU II	MTU III	MTU I	MTU II	MTU III
3	3	3	3	3	3	2	1	1



Number of Passes = 64

Table 6I

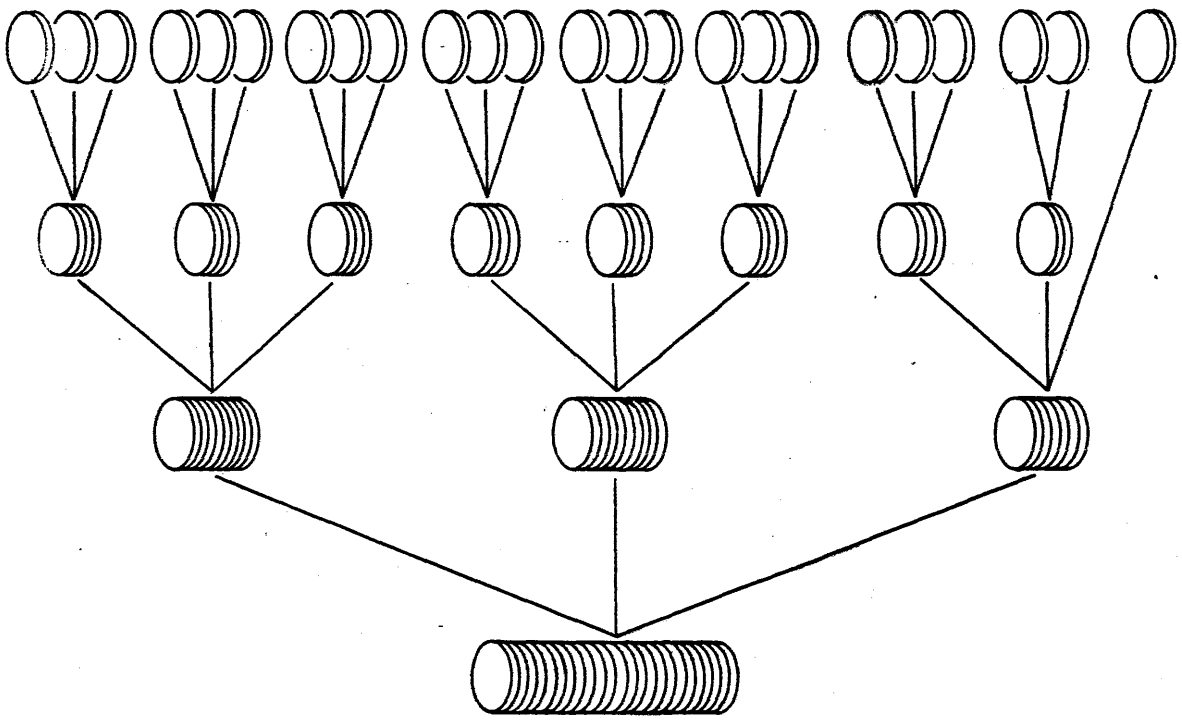
23 Reels								
MTU I			MTU II			MTU III		
9			9			5		
MTU I	MTU II	MTU III	MTU I	MTU II	MTU III	MTU I	MTU II	MTU III
3	3	3	3	3	3	3	1	1



Number of Passes = 67

Table 6J

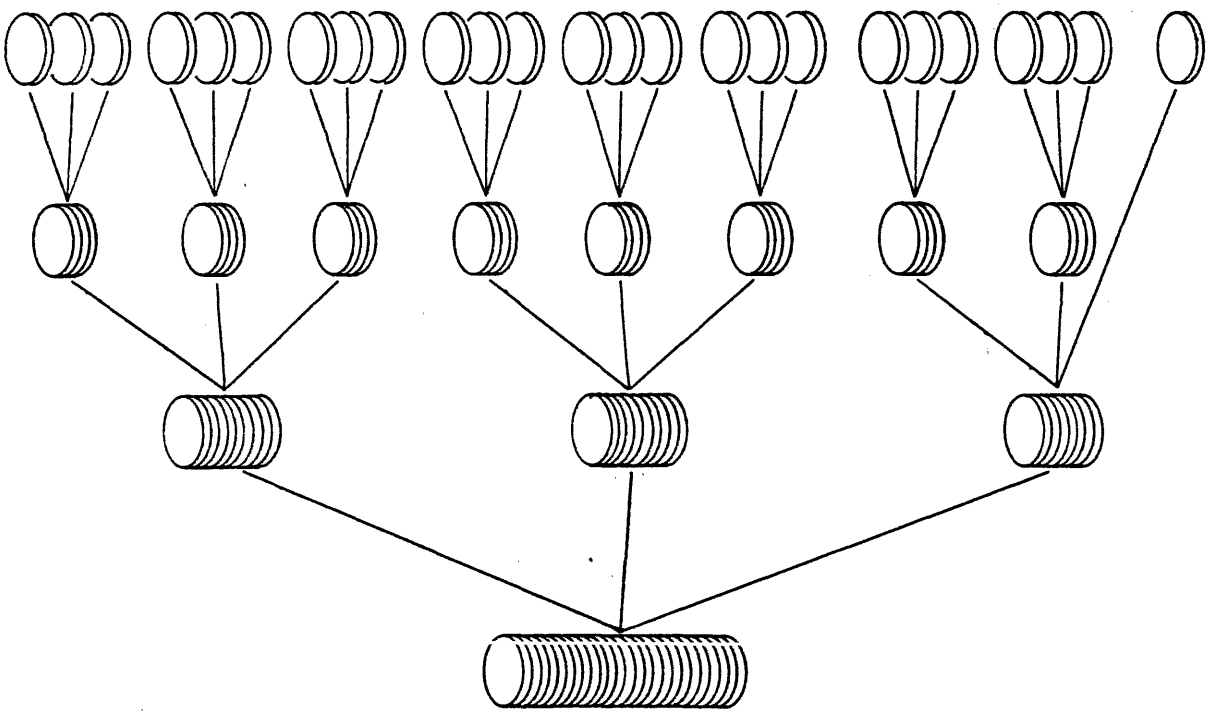
24 Reels								
MTU I			MTU II			MTU III		
9			9			6		
MTU I	MTU II	MTU III	MTU I	MTU II	MTU III	MTU I	MTU II	MTU III
3	3	3	3	3	3	3	2	1



Number of Passes = 71

Table 6K

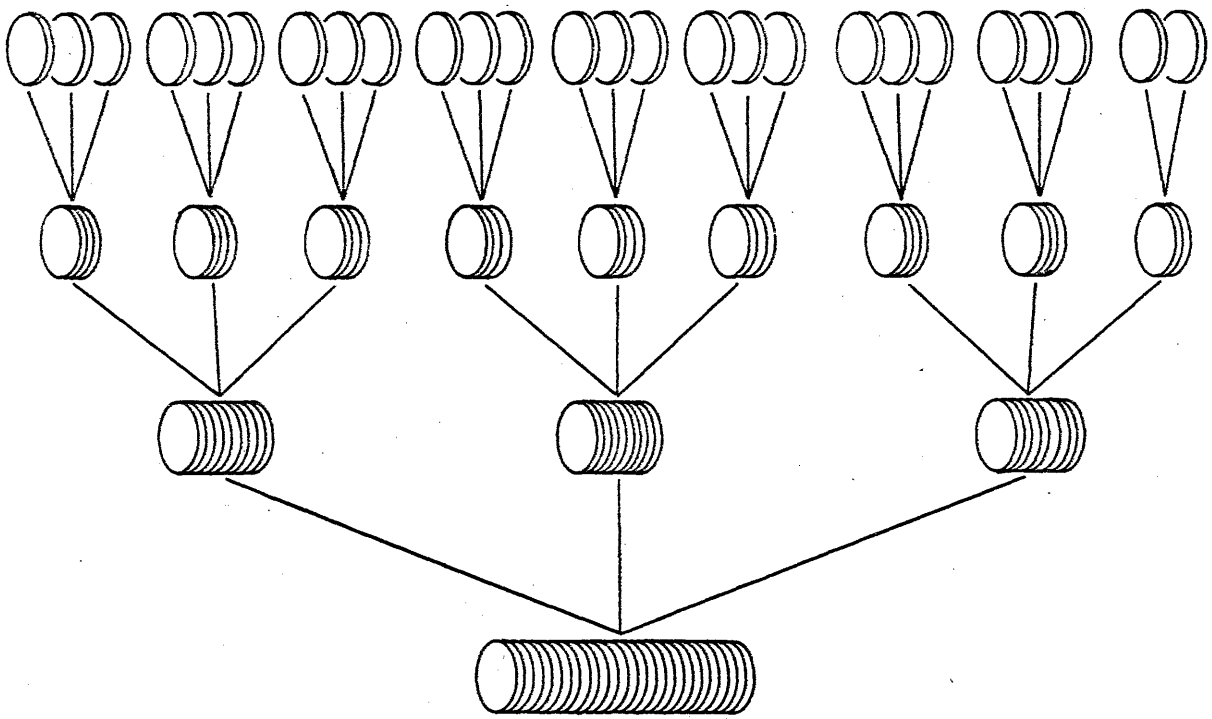
25 Reels								
MTU I			MTU II			MTU III		
9			9			7		
MTU I	MTU II	MTU III	MTU I	MTU II	MTU III	MTU I	MTU II	MTU III
3	3	3	3	3	3	3	3	1



Number of Passes = 74

Table 6L

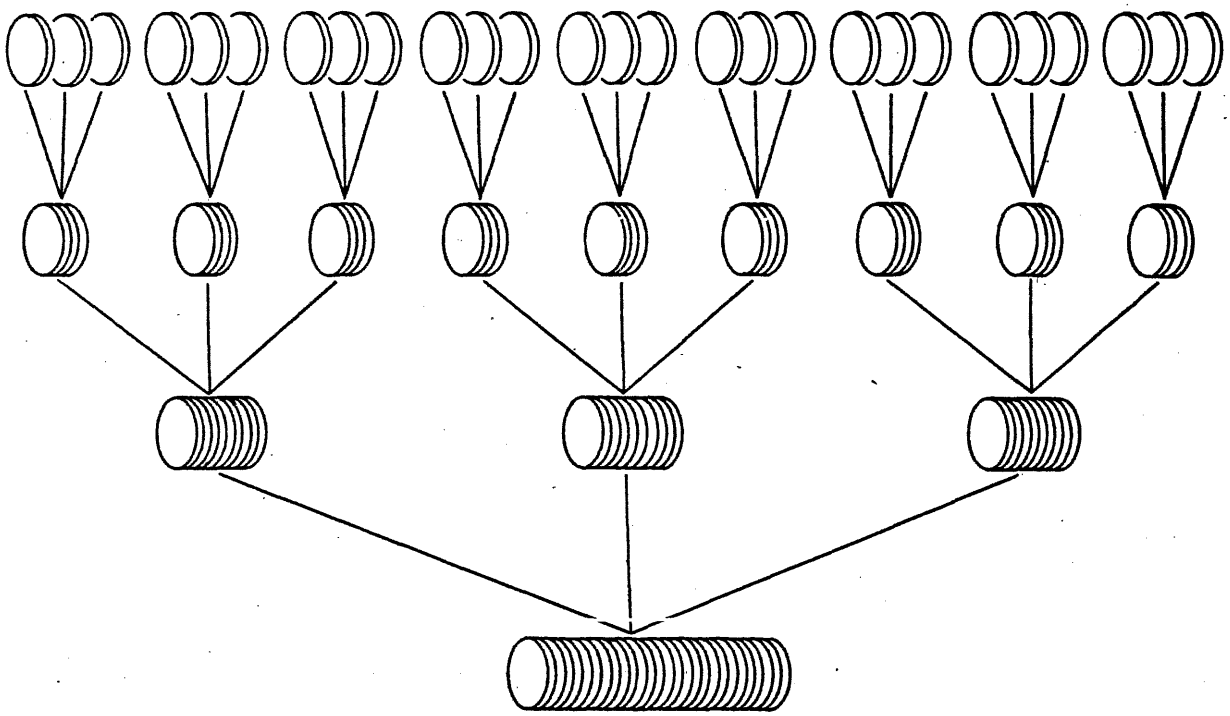
26 Reels								
MTU I			MTU II			MTU III		
9			9			8		
MTU I	MTU II	MTU III	MTU I	MTU II	MTU III	MTU I	MTU II	MTU III
3	3	3	3	3	3	3	3	2



Number of Passes = 78

Table 6M

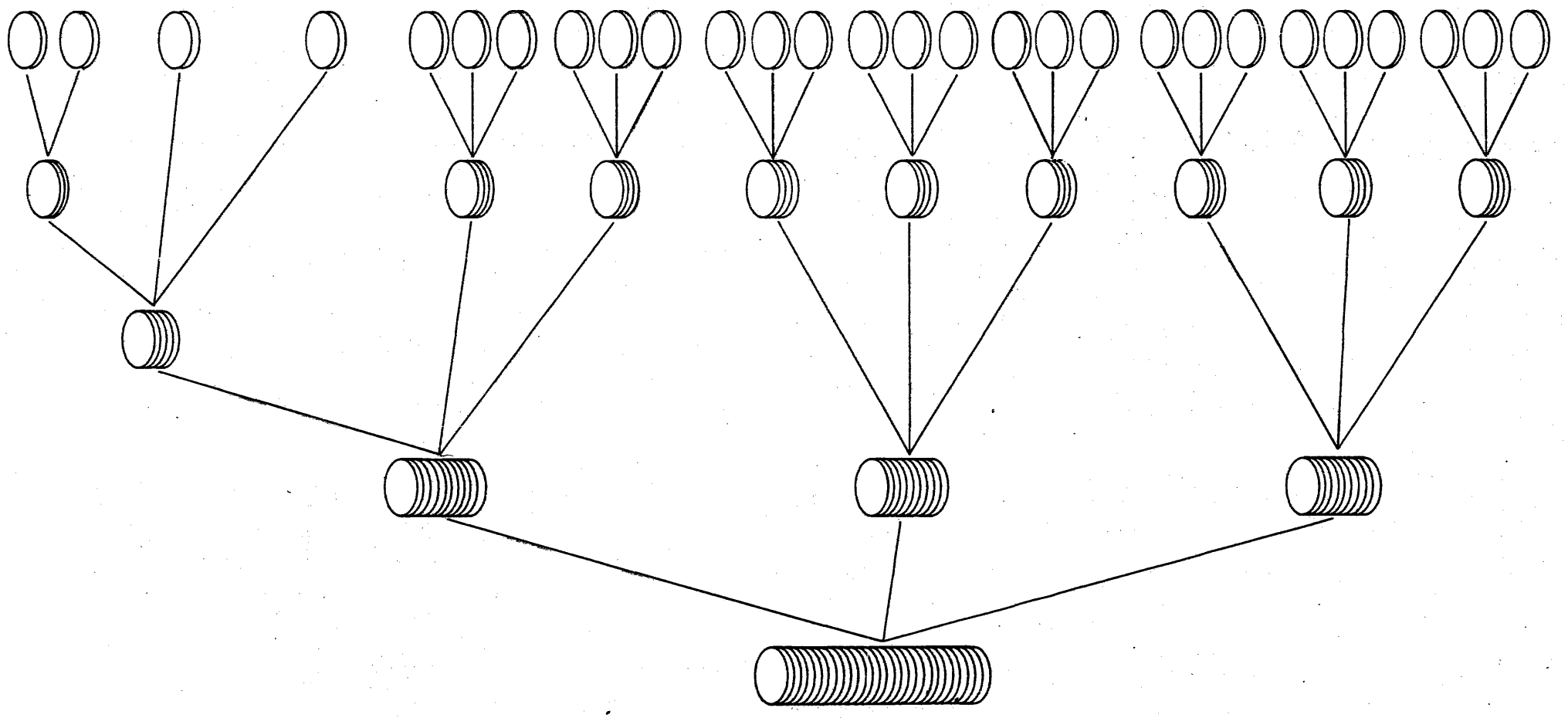
27 Reels								
MTU I			MTU II			MTU III		
9			9			9		
MTU I	MTU II	MTU III	MTU I	MTU II	MTU III	MTU I	MTU II	MTU III
3	3	3	3	3	3	3	3	3



Number of Passes = 81

Table 6N

28 Reels									
MTU I			MTU II			MTU III			
10			9			9			
MTU I	MTU II	MTU III	MTU I	MTU II	MTU III	MTU I	MTU II	MTU III	
4	3	3	3	3	3	3	3	3	
MTU I	MTU II	MTU III							
2	1	1							

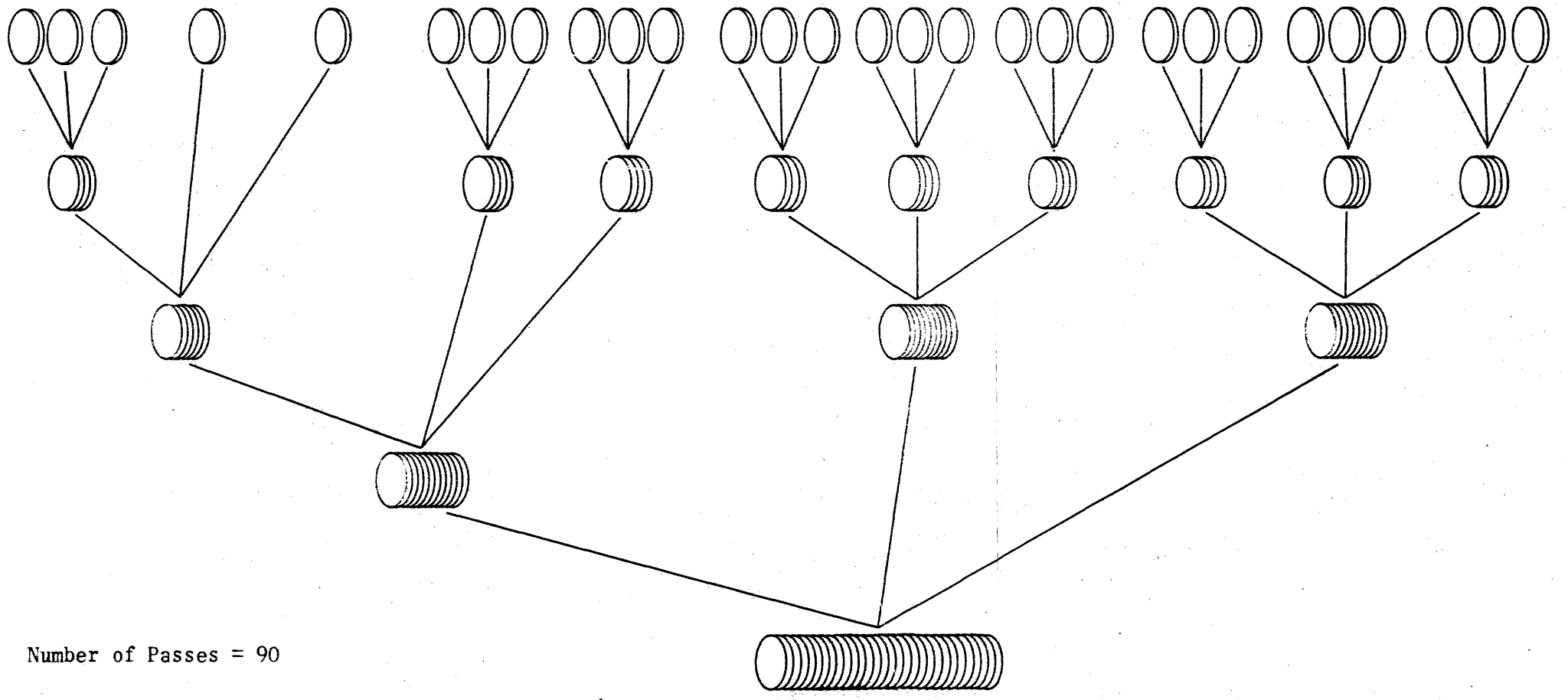


Number of Passes = 86

Table 60

29 Reels								
MTU I			MTU II			MTU III		
11			9			9		
MTU I	MTU II	MTU III	MTU I	MTU II	MTU III	MTU I	MTU II	MTU III
5	3	3	3	3	3	3	3	3

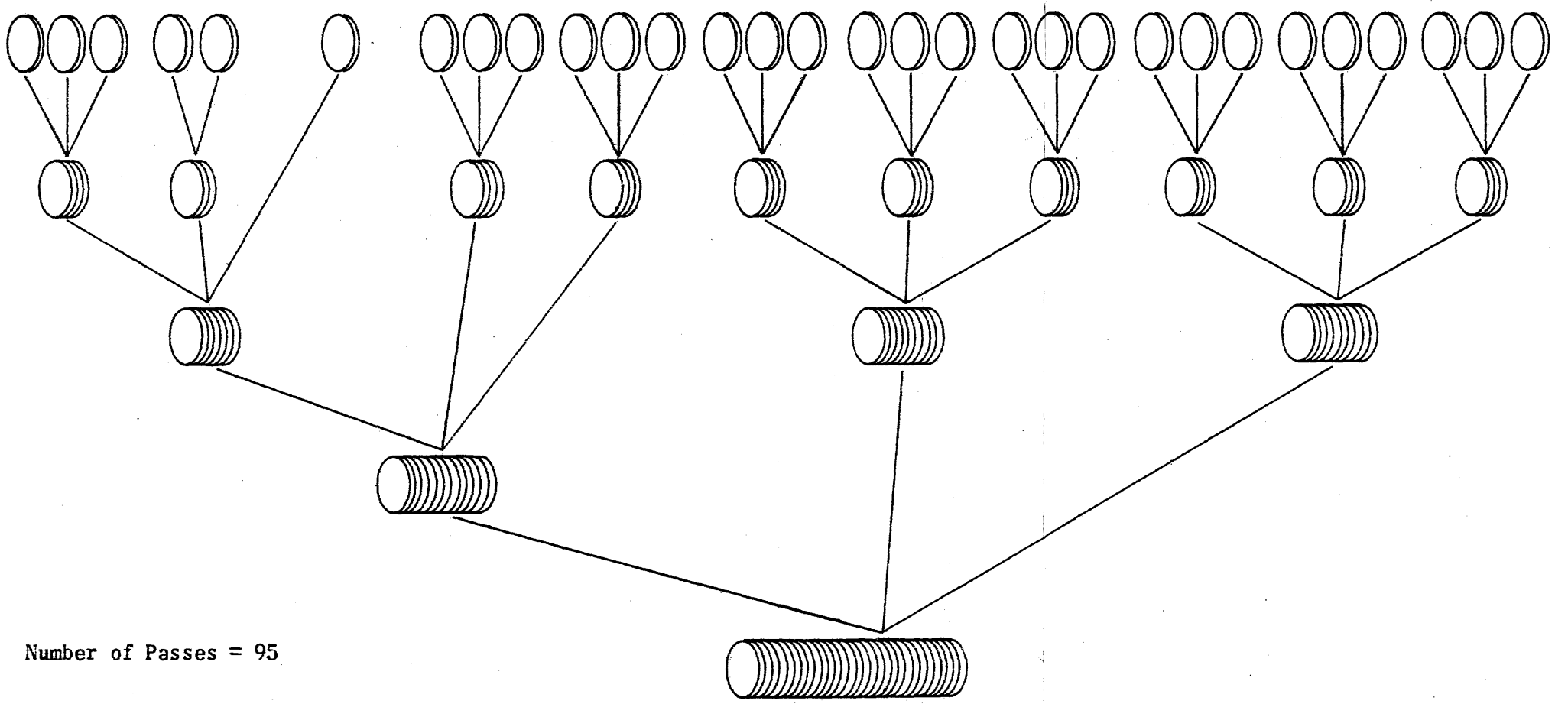
MTU I	MTU II	MTU III
3	1	1



Number of Passes = 90

Table 6P

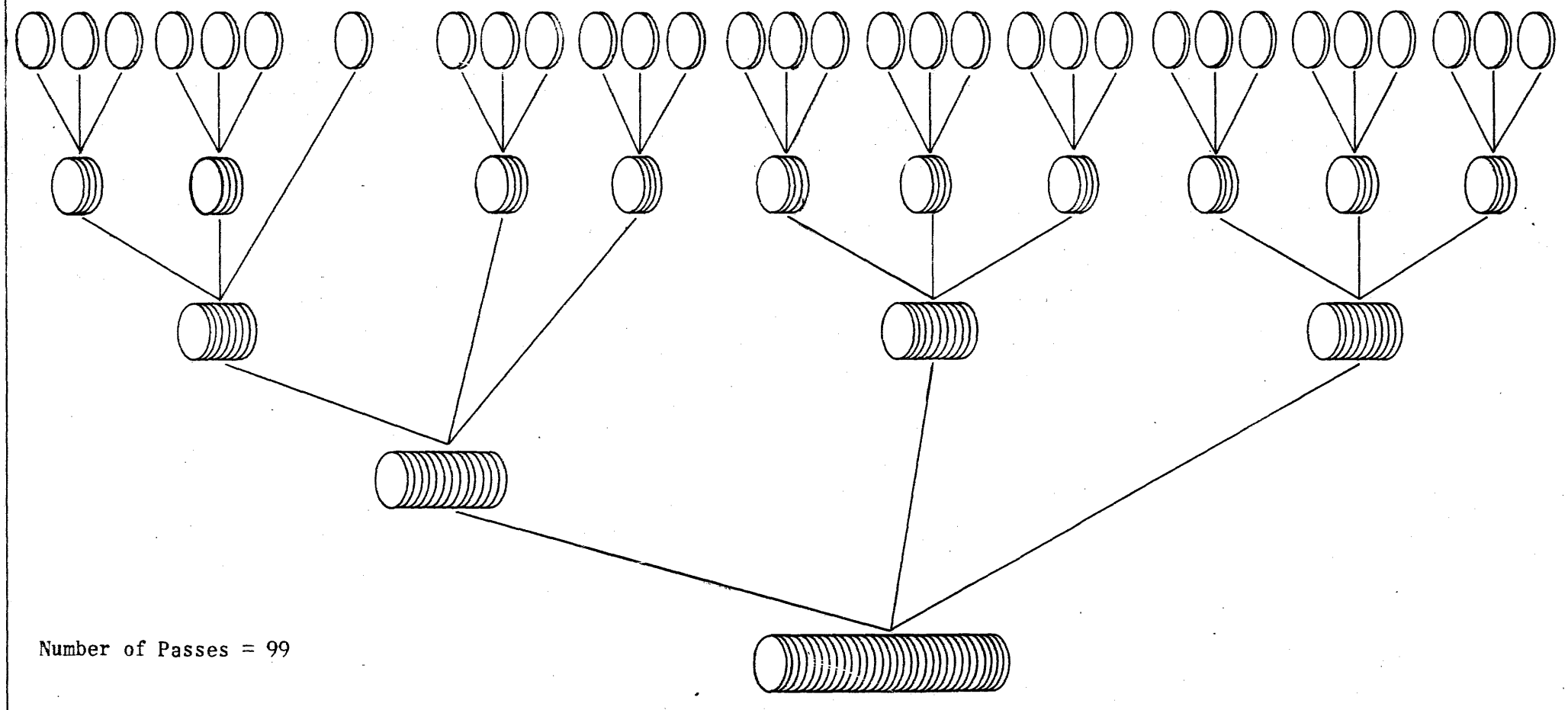
30 Reels								
MTU I			MTU II			MTU III		
12			9			9		
MTU I		MTU II	MTU III	MTU I	MTU II	MTU III	MTU I	MTU II	MTU III
6		3	3	3	3	3	3	3	3
MTU I	MTU II	MTU III							
3	2	1							



Number of Passes = 95

Table 6Q

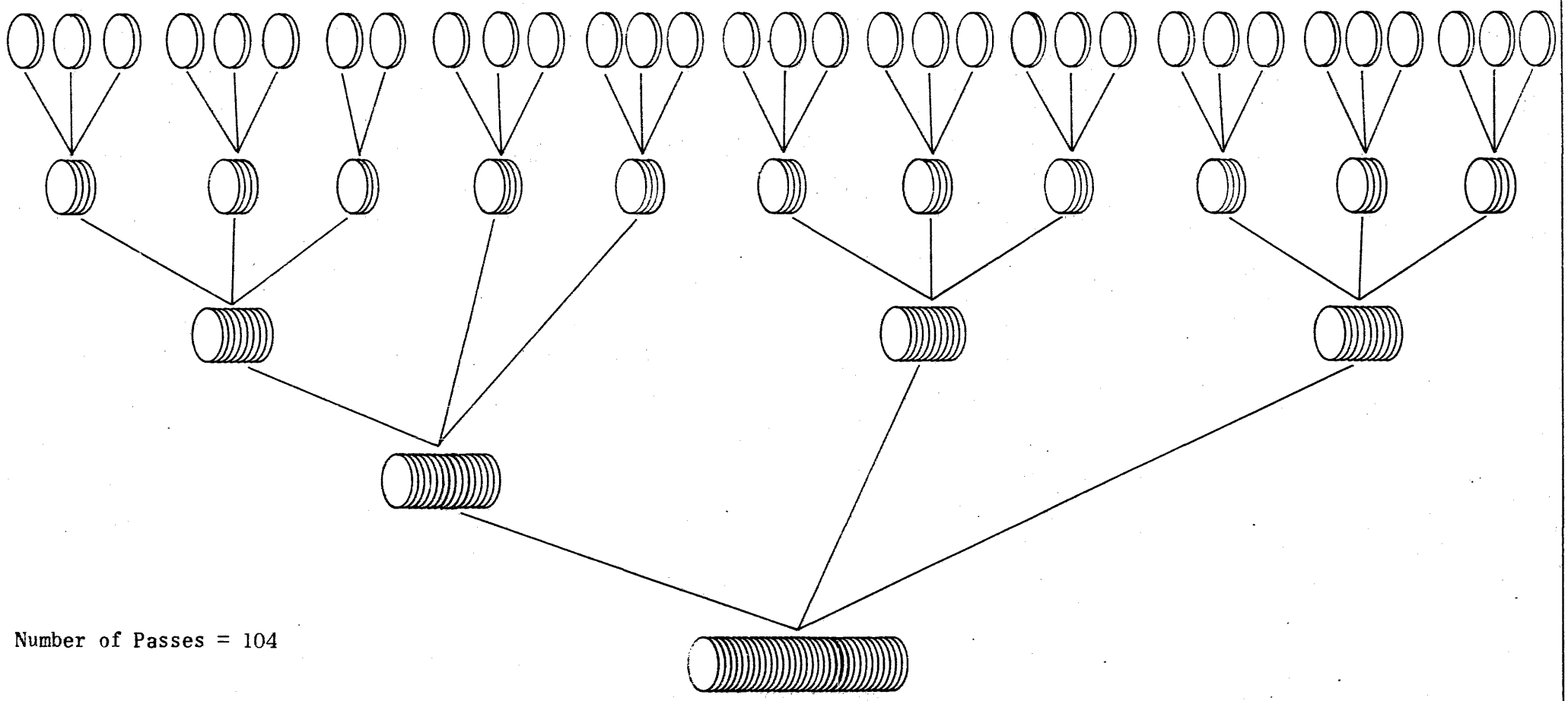
31 Reels									
MTU I			MTU II			MTU III			
13			9			9			
MTU I		MTU II	MTU III	MTU I	MTU II	MTU III	MTU I	MTU II	MTU III
7		3	3	3	3	3	3	3	3
MTU I	MTU II	MTU III							
3	3	1							



Number of Passes = 99

Table 6R

32 Reels									
MTU I			MTU II			MTU III			
14			9			9			
MTU I		MTU II	MTU III	MTU I	MTU II	MTU III	MTU I	MTU II	MTU III
8		3	3	3	3	3	3	3	3
MTU I	MTU II	MTU III							
3	3	2							

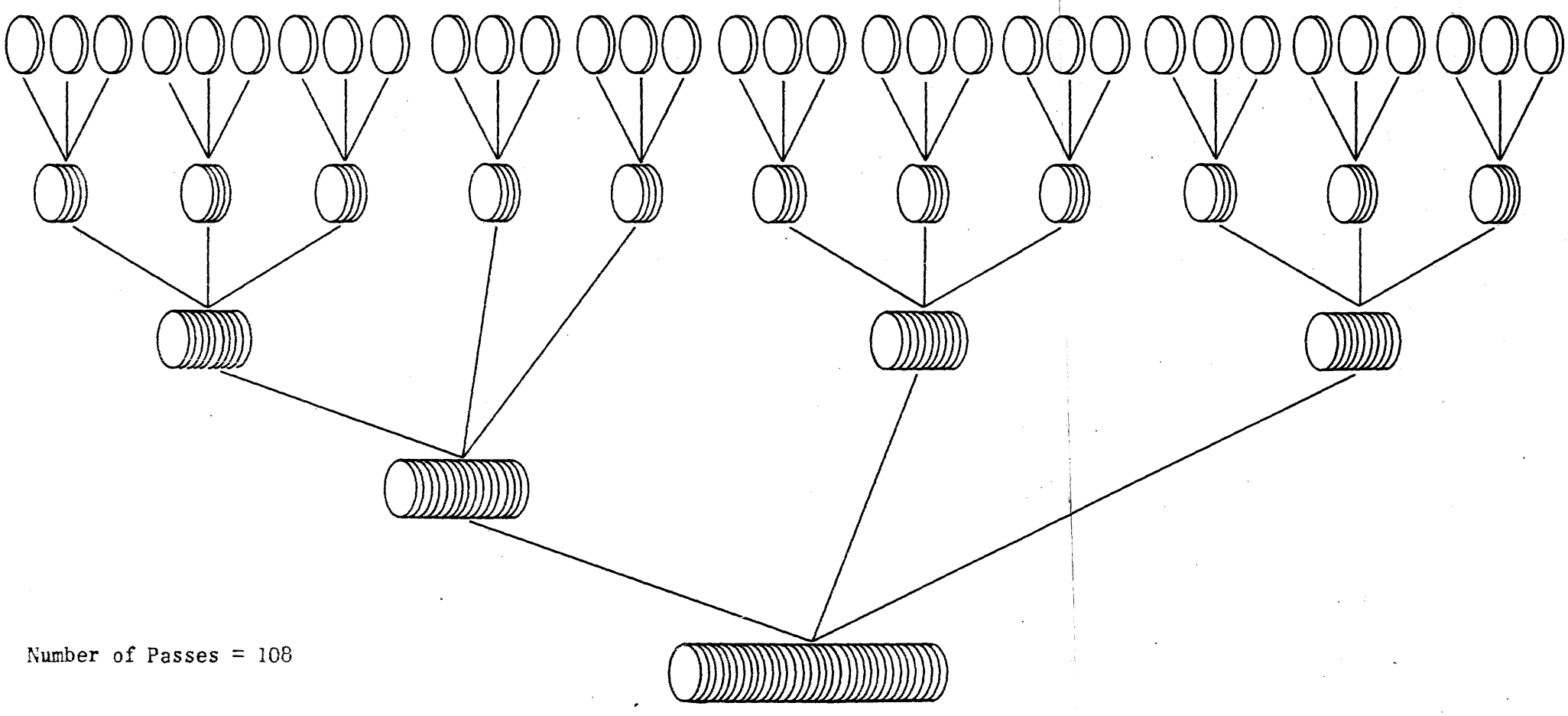


Number of Passes = 104

Table 6S

33 Reels								
MTU I			MTU II			MTU III		
15			9			9		
MTU I	MTU II	MTU III	MTU I	MTU II	MTU III	MTU I	MTU II	MTU III
9	3	3	3	3	3	3	3	3

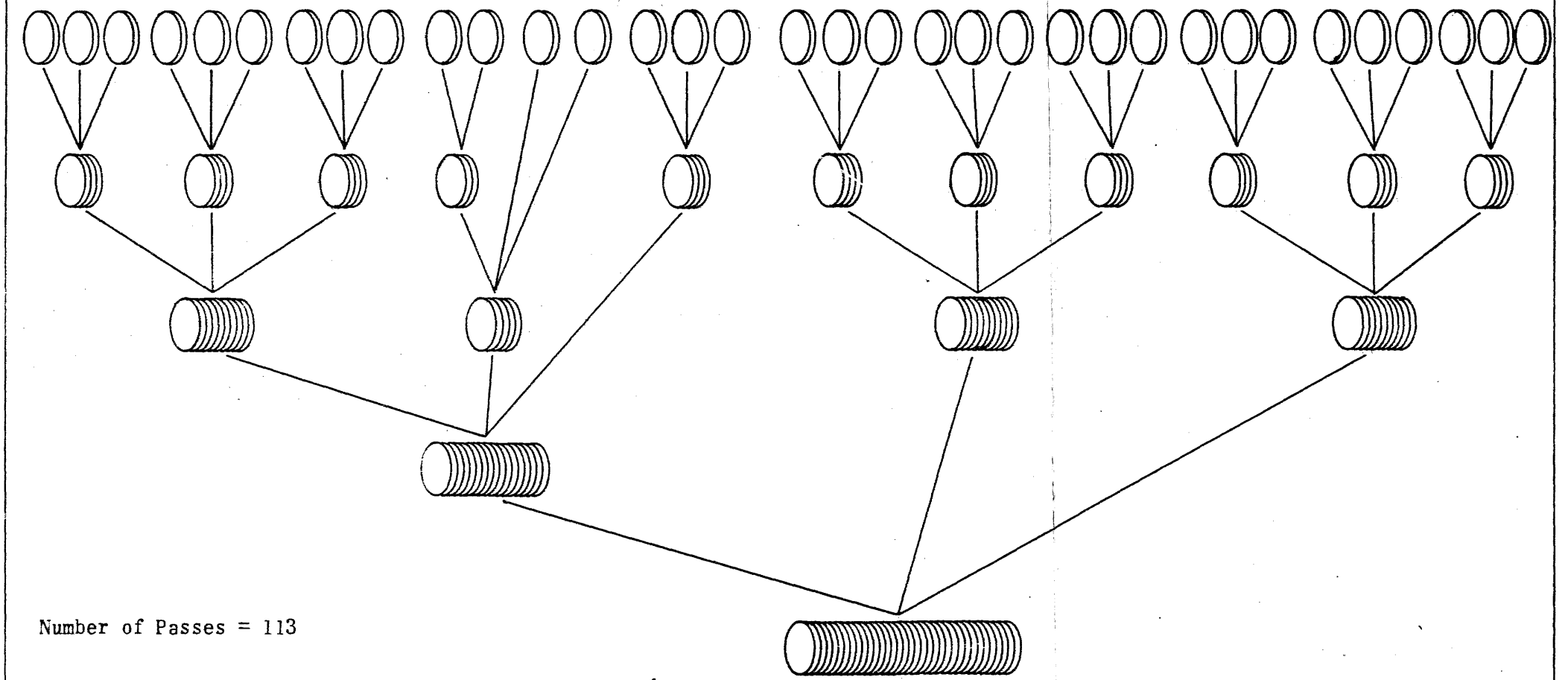
MTU I	MTU II	MTU III
3	3	3



Number of Passes = 108

Table 6T

34 Reels												
MTU I							MTU II			MTU III		
16							9			9		
MTU I			MTU II			MTU III	MTU I	MTU II	MTU III	MTU I	MTU II	MTU III
9			4			3	3	3	3	3	3	3
MTU I	MTU II	MTU III	MTU I	MTU II	MTU III							
3	3	3	2	1	1							



Number of Passes = 113

Table 6U

35 Reels											
MTU I						MTU II			MTU III		
17						9 9			9		
MTU I			MTU II			MTU III	MTU I	MTU II	MTU III	MTU I	MTU II	MTU III
9			5			3	3	3	3	3	3	3
MTU I	MTU II	MTU III	MTU I	MTU II	MTU III							
3	3	3	3	1	1							

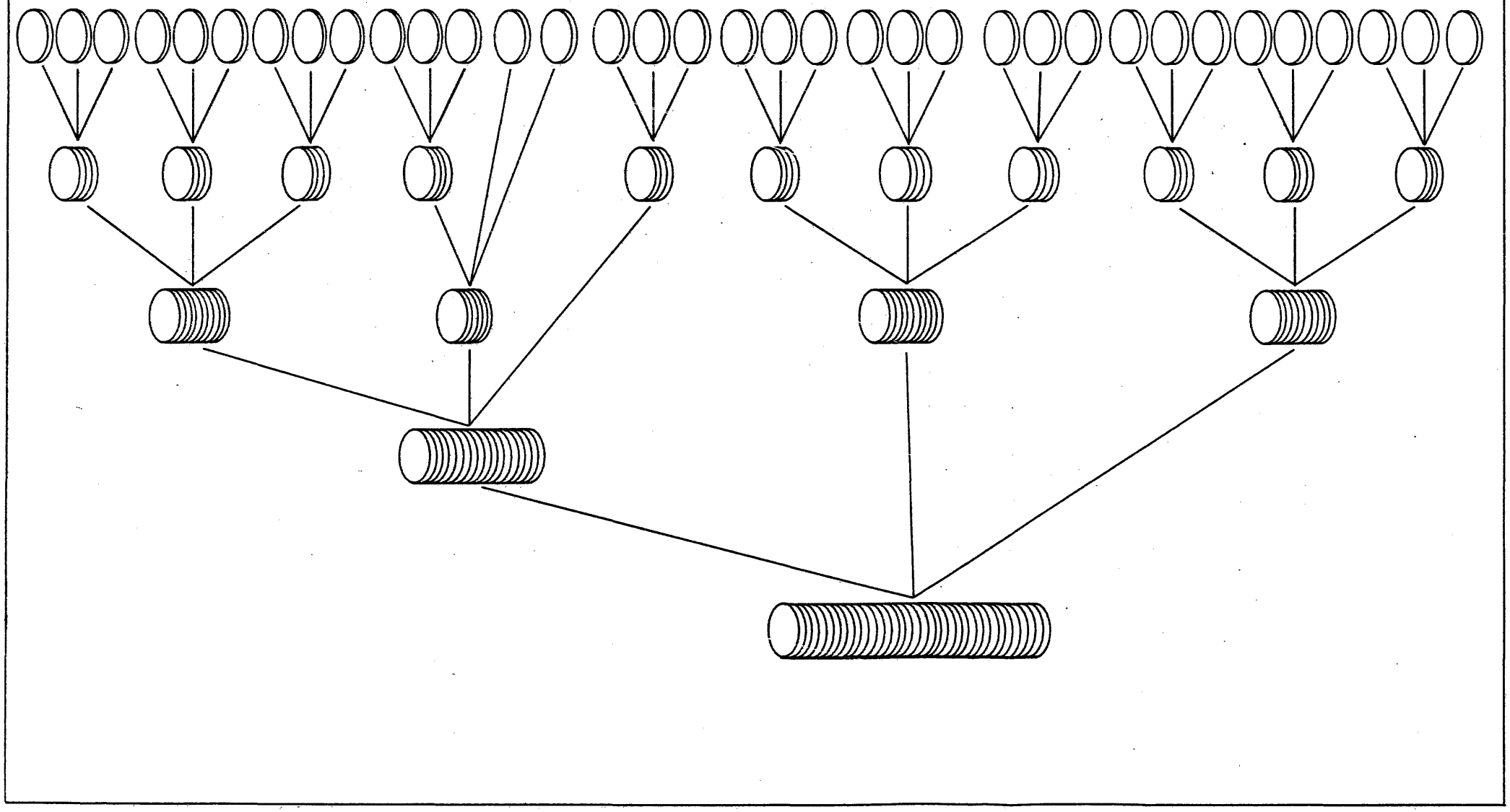


Table 6V

Chapter VI

OPERATING THE SORT-COLLATE SYSTEM

MAGNETIC TAPE CONTROL PANEL

A brief discussion of the major items on the Magnetic Tape Unit control panel is given in this manual to aid in sort-collate operations. Figure 11 shows a picture of the Magnetic Tape Control Panel.

The five decade tubes normally provide a visual picture of the blockette count. In normal operation only the READY lamp in the first row should be lit. The terminal condition neons are lit when the appropriate condition is detected by the tape unit. The next row contains the power and tape control buttons. When depressed the (POWER) ON, MANUAL, AUTO and INTLK buttons light, indicating a positive action has taken place. The tape control buttons should be depressed with caution, as the depressing of either of these buttons initiates the respective action for that tape unit, regardless of the sort-collate's mode of operation or current status.

The operator normally uses the tape units in an automatic mode of operation; i.e., with the AUTO button depressed. In this mode, the CLEAR button is interlocked such that it has no effect when depressed. The tape unit may then be master cleared only from the computer (in DEMAND MODE) or sort-collate (in SORT or COLLATE MODES) control panels. For testing purposes the technician may operate the tape unit in a MANUAL mode; in this event the depression of the CLEAR button clears the tape unit to its initial state.

As a protection against errors, the Sort-Collate System was designed so that the tape interlocks can be released only by depressing the CLEAR INTLK button on the tape control panel. This spotlights the fact that a rewind has occurred, and guards against the possibility of clearing an improper and undetected interlock by depressing the MASTER CLEAR on the sort-collate control panel.

SORT-COLLATE CONTROL PANEL

Figure 12 shows a picture of the Sort-Collate Control Panel. A-E, the operator's panel, is always visible and F-R, the maintenance panel, is not normally used by the operator.

Selector - Program (1-6, A-B)

The 6 neons numbered 1-6 light when the corresponding numbered program selects on the plugboard are impulsed. In all cases, the neons light or extinguish to indicate an action has taken place, the red buttons directly below the neons are used to set up the action, and the one black button clears the action.

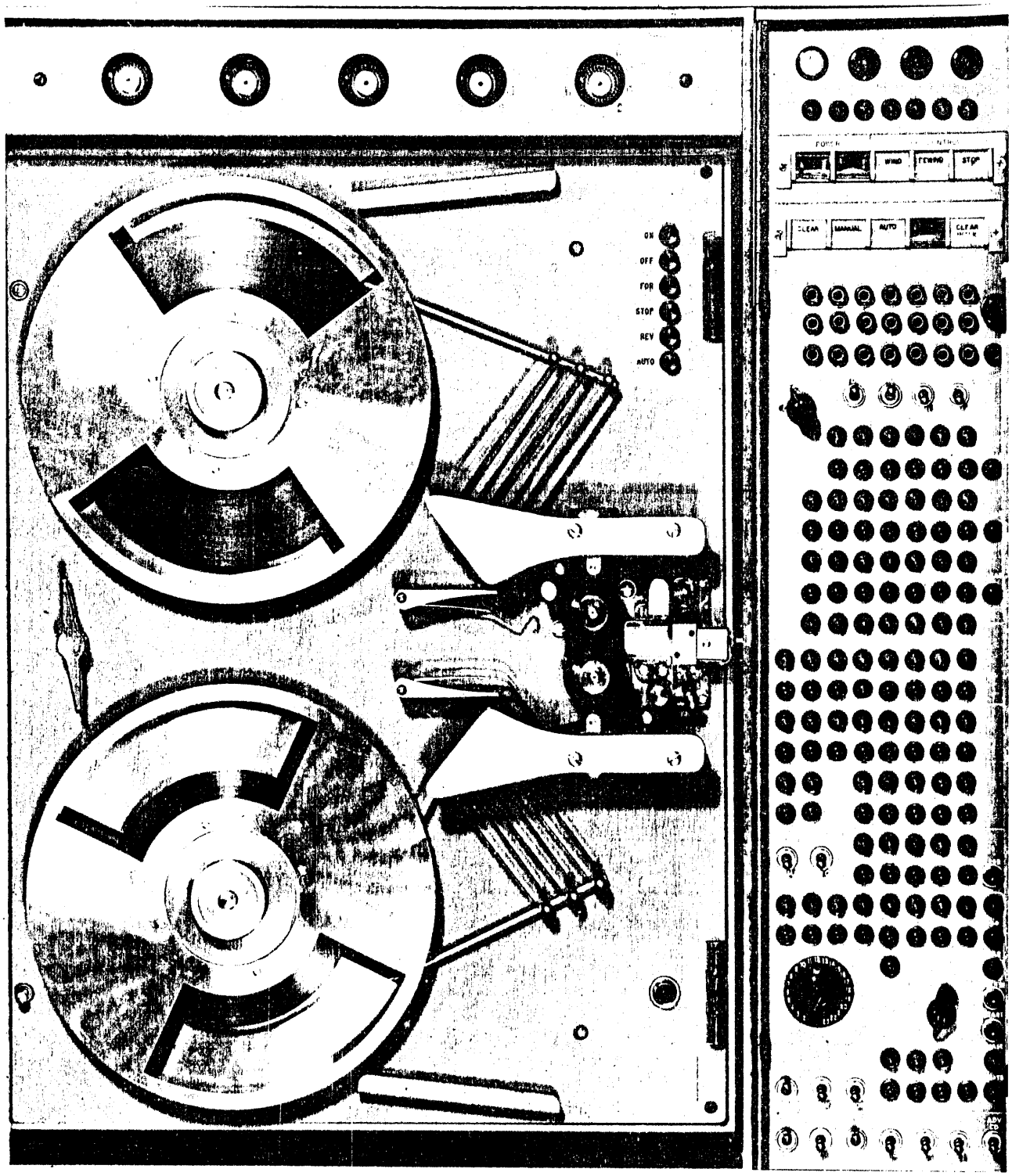


Figure 11. Magnetic Tape Control Panel

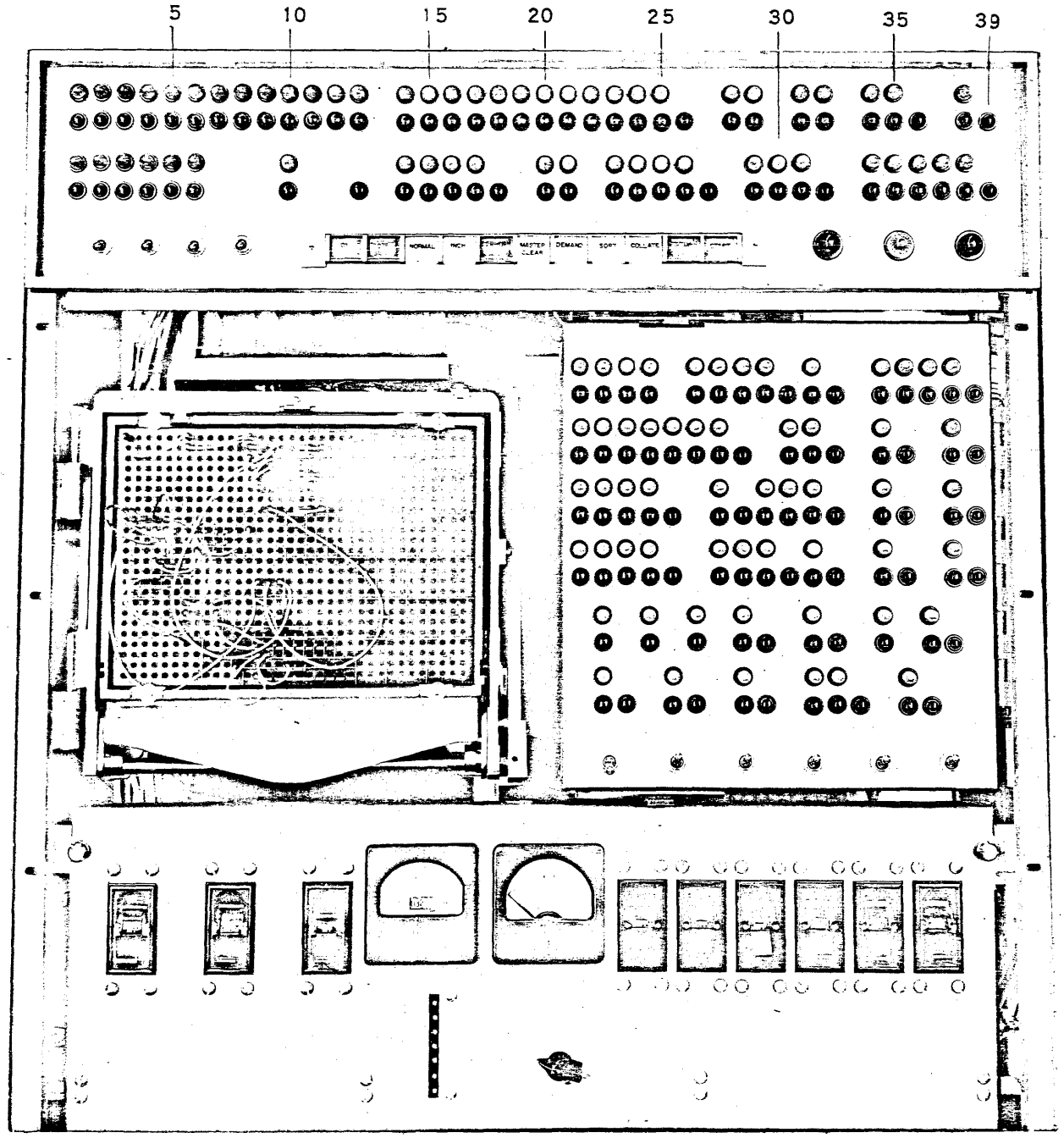


Figure 12. Sort-Collate Control Panel

Selector - Program Delay (1-6, C-D)

The impulsing of a program select on the sort-collate plugboard causes both the program and program delay neons to light, even though the delay out hub has not yet emitted a pulse. The program delay neon extinguishes when the delay out hub emits a pulse.

Selector - Terminal (7-13, A-B)

The neons and buttons operate for the terminal selects in the same manner as the program neons operate for the program selects.

Selector - Terminal Delay (10, C-D)

Whenever a terminal select is impulsed the terminal and terminal delay neons light. The illumination of the one terminal delay neon, common to all seven terminal program selects, specifies that the next step out pulse will be delayed. This neon extinguishes at the same time that the delayed step out pulse is emitted on the plugboard. The black button (13-D) clears all conditions in the selector box.

Steps (14-26, A-B)

The step neons indicate which step is "up"; i.e., the next step to be performed. In the event of error, the step neon also indicates in which step the error has occurred. In debugging procedures, the program can be started at the point specified by depressing of the step button, thus if step 4 is depressed, the program commences with step 4.

Compare Results (28-36, A-B)

These neons indicate the results of the last compare step. If Compare Mode III is wired, neons 31-32 indicate the results of I : II and neons 34-35 indicate the results of II : III. Only the > or < conditions are shown, thus if the results are equal neither neon is lit.

SC Error (38-39, A-B)

The SC Error neon and the ERROR button (17-18, E) are lit when an error is detected by the sort-collate unit.

Sub-Steps - Sequence (14-15, C-D)

The sequence neons, labeled A and B, indicate the logical sequence for the four processes. For programming purposes it is convenient to speak of the seven processes; however, technically, computer alert, wind and rewind, are not true processes. Computer alert is a sequence, and wind and rewind correspond to a Univac File-Computer interstep. Load and compare are single sequence processes whereas transfer and WED are two sequence processes.

Sub-Steps - Enable (16-18, C-D)

The neons labeled S and D indicate source and destination and correspond to the source and destination enables respectively on the plugboard. These neons are sometimes useful in error detection.

Control (20-21, C-D)

The sort-collate unit may perform control sequences; i.e., generate instructions and control information, only when the Control - SC indicator is lit. When the Control-TU indicator is lit, the sort-collate unit is waiting for one or more of the tape units to complete the last issued instruction. The tape units performing these instructions can be determined by observing the TU Active neons.

TU Active (23-27, C-D)

These neons indicate which of the tape units is active. Whenever the sort-collate unit issues an instruction to a tape unit, it sets that tape unit to an active status and lights the neon. The sort-collate unit waits until all tape unit active neons are extinguished, then takes control, and begins the next sequence.

Alert Computer Sequence (29-32, C-D)

A unique sequence of events is followed during a computer alert. Computer Alert is defined as a sequence of operations enacted by the sort-collate unit which effects the transfer of control of the four tape units from the sort-collate unit to the computer. This sequence occurs in three steps, and as each step occurs, one of the three alert computer sequence neons is illuminated. When all are illuminated, the sequence is complete.

Revert Control is that sequence wherein control of the four tape units is transferred from the computer back to the sort-collate unit. This sequence is also composed of three steps, and as each step occurs, one of the alert computer sequence neons is extinguished. When all lamps are extinguished the sequence is completed and normal collation is resumed if so stipulated in the plugboard program.

The following sequence of operations is involved in a Computer Alert Sequence:

1. Step One

    a) One of the computer alert hubs 1-15 on the plugboard is impulsed, and collation ceases.

    b) The condition (value of 1-15 hubs) is translated into binary representation, and stored for later transmission to the computer over high speed lines.

    c) The four tape units are informed that data transmissions are to be sent and received from the I/O track rather than the sort-collate data bus. In effect, all tape units go off demand (they were

all on demand to the sort-collate unit); i.e., all tape units go NOT READY.

d) Alert computer sequence lamp 1 is lit.

2. Step Two

a) All four tape units are instructed to send data contained in their buffers to their associated I/O track (the buffers are copied in the I/O tracks), and drum timing pulses are made available to the I/O drum.

b) Output control lines from the computer are switched through sort-collate to the tape units.

c) Now "Test In" and "Demand In" lines for MTU II, MTU III and MTU IV are connected through sort-collate.

d) MTU I demand line is set up for later use in step three.

e) MTU I's "Test In" pulse logic is switched such that the computer test in pulse actually tests MTU I instead of automatically getting a NOT READY response.

f) Alert computer sequence lamp 2 is lit. (The computer program must "Test In" MTU I, and only when a READY response is received, can step three be initiated.)

3. Step Three

a) The computer program must "Demand In" on MTU I's lines. This "Demand In" pulse causes the following actions.

b) The balance of the control lines are switched.

c) A "Special Out" pulse is issued by sort-collate to the computer.

d) The stored special conditions are sent over the high speed control lines to the computer.

e) Alert computer sequence lamp 3 is lit, and the computer alert sequence is completed with all three lamps remaining lit.

Control must eventually revert back to the sort-collate unit. The following sequences of operations is involved in a Revert Control Sequence:

1. Step One

a) The computer impulses one of the control lines E-I which is wired to the resume in hub on the sort-collate plugboard.

b) Alert computer sequence lamp 1 is extinguished.

c) The tape units are tested. If active, this condition is set up in the sort-collate unit's TU Active indicators and Control is set to TU.

2. Step Two

a) Alert computer sequence lamp 2 is extinguished.

b) MTU I's "Test In" lines are conditioned such that a NOT READY response is always given to the computer.

c) Remaining "Test In" and all four "Demand In" lines are disconnected from the tape units.

d) All other switching of control lines to sort-collate unit occurs at this point.

e) At this point, the Revert Control Sequence halts until all tape units which were active (condition set up in 1-c) reach the end of their operations.

3. Step Three

a) Alert computer sequence lamp 3 is extinguished.

b) Drum timing pulses are cut-off from the tape units.

c) The four tape units are informed that all future data transmissions will be to and from sort-collate data bus rather than I/O track.

d) A "Resume Out" pulse is emitted from the sort-collate plugboard and the Revert Control Sequence is completed with all lamps extinguished.

Terminal Conditions (34-39, C-D)

These neons emit when the specified terminal conditions are detected. Note that EF is not indicated by neons.

Program Alteration Switches (2-8, E)

These switches govern the status of the respective alternate selectors. If set to ON that particular alternate switch will have its current routed through the select side; if set to OFF the current will be routed through the non-select side.

ON-OFF (12-13,E)

This row consists of four general types of buttons. The operation buttons (ON, OFF, STOP and START) are green, the ERROR button is red, mode buttons (NORMAL,

INCH, DEMAND, SORT and COLLATE) are yellow and the MASTER CLEAR is white. With the exception of (POWER) OFF, these buttons light when depressed indicating a positive action has taken place. The ON-OFF buttons indicate the condition of the power supply.

NORMAL - INCH (14-17, E)

The NORMAL button is depressed for normal operation. For testing or debugging operations, the sort-collate unit may be used in the INCH mode. In this mode, the pressing of the START button progresses the program through one logical sequence per blockette. Thus for a transfer step (two sequence process) of a single blockette item size, the START button must be pressed twice to complete the transfer. To perform a compare (one sequence) for the same single blockette item, the START button need be depressed only once. The START button must be depressed 10 times in the INCH mode to transfer a 5 blockette item size.

ERROR (17-18, E)

The ERROR button is lit if either a tape unit or sort-collate error is detected. The SC Error neon (38A) is also lit if the error is a sort-collate error. If only the ERROR button is lit, a tape error is indicated, and the ERROR lamp on the MTU is lit. In general, the sort-collate unit should not be master cleared if an attempt is made to recover from the error. Refer to topic on Demand Mode in this chapter.

MASTER CLEAR (19-20, E)

The MASTER CLEAR button is effective only when the sort-collate unit is in a STOP mode of operation. If in a STOP mode, depressing the MASTER CLEAR clears the sort-collate unit to its initial state. In SORT or COLLATE (as well as STOP) mode, depressing this button also clears the tape unit to its initial state providing no tape unit error is present. If a tape unit error is present, the error must first be cleared at the tape unit prior to depressing the MASTER CLEAR. In DEMAND mode, depressing this button clears the sort-collate unit but has no effect on the computer or tape units; however, the computer's master clear clears both the computer and the tape units.

The sort-collate unit is put into a STOP mode of operation by depressing the STOP button or the ERROR button. Upon completion of a sequence check or a sort, the sort-collate unit remains in a START mode, even though no tape movement is presently involved. Thus depressing the MASTER CLEAR is ineffective. To clear the sort-collate unit, press STOP and then the MASTER CLEAR button.

MODE (21-25, E)

The desired mode of operation; i.e., DEMAND, SORT or COLLATE, is set up by depressing the respective mode buttons. Note that the sort-collate unit is always operated in three "modes", that is, one button in the following three groups must be chosen: (1) NORMAL or INCH, (2) DEMAND, SORT or COLLATE, and (3) STOP or START.

STOP - START (25-28, E)

The depressing of the STOP (as well as ERROR) button puts the sort-collate unit in a stop mode. The MASTER CLEAR is not effective unless the sort-collate unit is in a stop mode.

END SORT (32, E)

This lamp lights after the completion of a successful sequence check or a sort operation.

REWIND (35, E)

The REWIND lamp illuminates when the sort-collate unit initiates a rewind. It does not light when the rewind is initiated from the tape control panel. The rewind lamp extinguishes when either the MASTER CLEAR or the START button is depressed; however, the tape interlock remains set and can be released only at the tape unit.

OVER TEMP (38, E)

The OVER TEMP lamp lights if the temperature within the sort-collate cabinet reaches 125° F. The OVER TEMP lamp is thus a signal that the components of the cabinet are being operated beyond the maximum safe temperature. This condition requires the immediate services of maintenance personnel. (If ignored and the temperature rises inside the cabinet to 140° F, sort-collate operations stop and power is lost.)

DEMAND MODE

The sort-collate unit must be in a "normal operating" condition before any mode of operation can be chosen and any program initiated. This "normal operating" condition is as follows:

On the Sort-Collate Unit:

1. OVER TEMP lamp must not be lit.
2. ON button must be lit.
3. STOP button must be lit.
4. NORMAL button must be lit.
5. ERROR button must not be lit. At this point, no attempt at recovering from an error is necessary, rather the error should be cleared. Thus, if the error is a sort-collate error only (SC Error lamp lit, no ERROR lamps on TU's lit) pressing the MASTER CLEAR should clear the sort-collate and tape units and extinguish the ERROR button. If the error

is due to the tape units, the error must first be cleared at the tape units by depressing the ERROR-CLEAR. Then depress the MASTER CLEAR in the sort-collate unit.

6. Although the maintenance panel will not normally be used by an operator, it is well to note that all switches in the row beginning with Filament and DC Supplies should be set to the ON position.

On the Tape Units:

1. ON button should be lit.

2. Only READY lamp should be lit.

3. If ERROR lamp is lit, clear the error by depressing ERROR-CLEAR as noted in (A 5) above.

4. If TEMP lamp is lit call a technician.

5. If ABNORM lamp is lit check to see if the tape is correctly mounted. If so, and the lamp is still lit, call a technician.

6. AUTO button should be lit. If the MANUAL button is lit, press CLEAR and AUTO buttons in that order. Only AUTO button should then be lit.

7. If INTLK button is lit, press CLEAR INTLK button.

Discussion of the three modes of operation starts from this point.

The following points must be noted to operate the tape units in the DEMAND mode of operation. It is assumed that the sort-collate unit and all tape units are in normal operating condition.

1. Mount the tapes on correct tape units. Blank tapes do not need to be mounted on unused tape units in the DEMAND mode. This is the only mode of the three for which this is true.

2. Set the UFC-UNIVAC switch to the correct setting. This switch affects the blockette spacing and blockette counter. UFC mode is .5 inches between blockettes and UNIVAC mode is 1.0 inch between blockettes and 2.4 inches between blocks (every 6 blockettes).

   With the switch set to UFC, the UFC spacing is chosen for writing, the blockette counter is activated for all tape movements except wind and a tape written in UNIVAC mode can be read even though the switch is set to UFC. With the switch set to UNIVAC, the UNIVAC spacing is chosen for writing and the blockette counter is activated for writing only; thus no blockette count is available on a read. Again, a tape written in UFC mode can be read even though the switch is set to UNIVAC.

3. If searching operations are a part of the computer program, set the UR LENGTH switch on tape maintenance control panel to either 60 or 120 depending on whether the item length is 60 characters or at least one blockette. The setting of this switch effects the MTU's operation only in the DEMAND mode and then only on searching operations. It has no effect on the sort-collate unit or tape units in the other two modes or in reading or writing operations in the DEMAND mode.

4. In this mode the computer program has control of the tape units. The MASTER CLEAR of the computer clears both the computer and tape units, except interlocks, to their initial status. The computer can initiate a rewind or a rewind with interlock. The former is cleared by MASTER CLEAR, the latter must be cleared at the tape unit. Further, the initiation of a rewind or rewind with interlock by the computer does not "hang up" the system and has no effect on the program or other equipment.

SORT MODE

Sequence Check

The following points must be noted to initiate a sequence checking operation. It is assumed that the sort-collate unit and all tape units are in normal operating conditions.

1. Mount the tape to be checked for sequence on MTU I.

2. Mount blank tapes on the other three tape units. Each tape unit must have a tape reel mounted otherwise the tape unit will report an abnormal condition due to a broken tape.

3. Set UFC - Univac switch to correct setting. This will normally be set to UFC.

4. Depress SORT button on sort-collate unit.

5. Depress MASTER CLEAR button on sort-collate unit.

6. Depress START button on sort-collate unit. A single pass is made through the tape. The data is either in sequence or it is not.

7. If the tape data is in sequence:

   a) The checked file is reproduced on MTU III.

   b) The END SORT lamp is lit.

   c) All MTUs are rewound with interlock even though MTU II and MTU IV had no tape movement. The REWIND lamp on the sort-collate unit is lit.

d) Remove the original file from MTU I and the duplicate file from MTU III.

e) Depress the CLEAR INTLK button on all four tape units.

f) A rewind may stop the program but it does not put the sort-collate unit in a STOP mode; therefore, as the sort-collate unit is in a START mode, the accidental depressing of the MASTER CLEAR is ineffective.

g) As the file is in sequence, the first pass conditions do not need to be retained, therefore, press STOP then MASTER CLEAR buttons. The Sort-Collate System is now ready for the next sequence checking operation.

8. If the tape data is not in sequence:

a) The file to be checked is reproduced partly on MTU III and partly on MTU IV.

b) The END SORT lamp is not lit.

c) Only MTU I is rewound with interlock. The REWIND lamp on the sort-collate is lit.

d) Replace the original file on MTU I with a blank reel. This is not essential but it is strongly recommended.

e) Depress the CLEAR INTLK button on MTU I.

f) As noted in (7 f) above, the sort-collate unit is still in a START mode of operation. This is an additional protection designed into the system to prevent accidental depressings of the MASTER CLEAR button from clearing out the first pass conditions.

g) A sort can be initiated from this point merely by depressing the START button.

Automatic Sort

As noted in point (8 g) above, the automatic sort is initiated by:

1. Depressing the START button.

2. Sorting commences under control of the internally wired sort routine. Once initiated the accidental depressing of the MASTER CLEAR will in no way hinder the sorting routine. If the STOP button is depressed, sorting can be resumed from the point of interruption by depressing the START button providing no other buttons were depressed in the interim.

3. Sorting continues to completion when all MTUs are rewound with interlock, and the REWIND lamp is lit.

4. The END SORT lamp is lit.

5. Remove the sorted tape from MTU III. Note that a tape produced in one blockette spacing, such as UNIVAC spacing, can serve as input for the sort, and the final tape can be produced in the other spacing medium, such as UFC. The setting of the switch for MTU III controls the spacing for the final sorted tape.

6. Depress the CLEAR INTLK button on all tape units.

7. Depress the STOP button.

8. Depress the MASTER CLEAR. The Sort-Collate System is now ready for the next sequence checking operation (1st pass of the sort).

PROGRAM COLLATE MODE

The following procedure should be used to initiate a collation program assuming the sort-collate unit and all tape units are in normal operating condition:

1. Mount the plugboard securely in the sort-collate unit.

2. Mount the tapes on the proper tape units. If the collation program has at least one compare step, then all tape units must contain a reel of tape whether it be a data reel or a blank reel.

3. Set UFC-UNIVAC switch to the proper setting.

4. Depress the COLLATE mode button.

5. Depress the MASTER CLEAR button on the sort-collate unit.

6. Depress the START button on the sort-collate unit. The program commences from the point specified by the wiring of the Start hub.

To resume a collation program after the program is interrupted for a rewind, the following procedure should be noted:

1. When the sort-collate unit initiates a rewind, the entire system waits until the rewind is completed. The tape (or tapes) are rewound with interlock and the INTLK button is lit.

2. The REWIND lamp on the sort-collate unit is lit.

3. Do any necessary reel changing.

4. Depress the CLEAR INTLK button on the rewound tape units.

5. When all interlocks are cleared, the program may be reinitiated from the point specified by the wiring of the rewind out hub by depressing the START button. The REWIND lamp extinguishes. (This lamp extinguishes when either the START or MASTER CLEAR buttons are depressed.)

6. As mentioned previously, the rewind stops the program, but does put the Sort-Collate System in a STOP mode of operation. This protection feature is very important at this point (where the program has been stopped for a rewind), for at this point the depressing of the MASTER CLEAR button is not effective, and thus will not destroy the conditions set up by the program.

Chapter VII

APPLICATIONS AND SOLUTIONS

The following routines are examples of typical applications and solutions for the sort-collate unit. In all cases it is assumed that the item length and compare positions of the plugboard are appropriately wired. It is also assumed that the Sort-Collate System is being used as an integral part of the Univac File-Computer Model 1 System and is set to the PROGRAM COLLATE MODE of operation.

THREE-WAY MERGE WITH COMPUTER ALERT FOR HANDLING TAPE LABELS

File I consists of the inventory transactions in ascending sequence by stock numbers for Monday and Tuesday; File II is the transactions for Wednesday and Thursday and File III is the transactions for Friday and Saturday. Any one of these three files may be multi-reel. They are to be merged into one file to be processed against the master file. The following charts are included:

Figure 13 is the Flow Chart

Figure 14 is the Program Chart for the Collation Program

Figure 15 is the Function Chart

Figure 16 is the Selector Chart

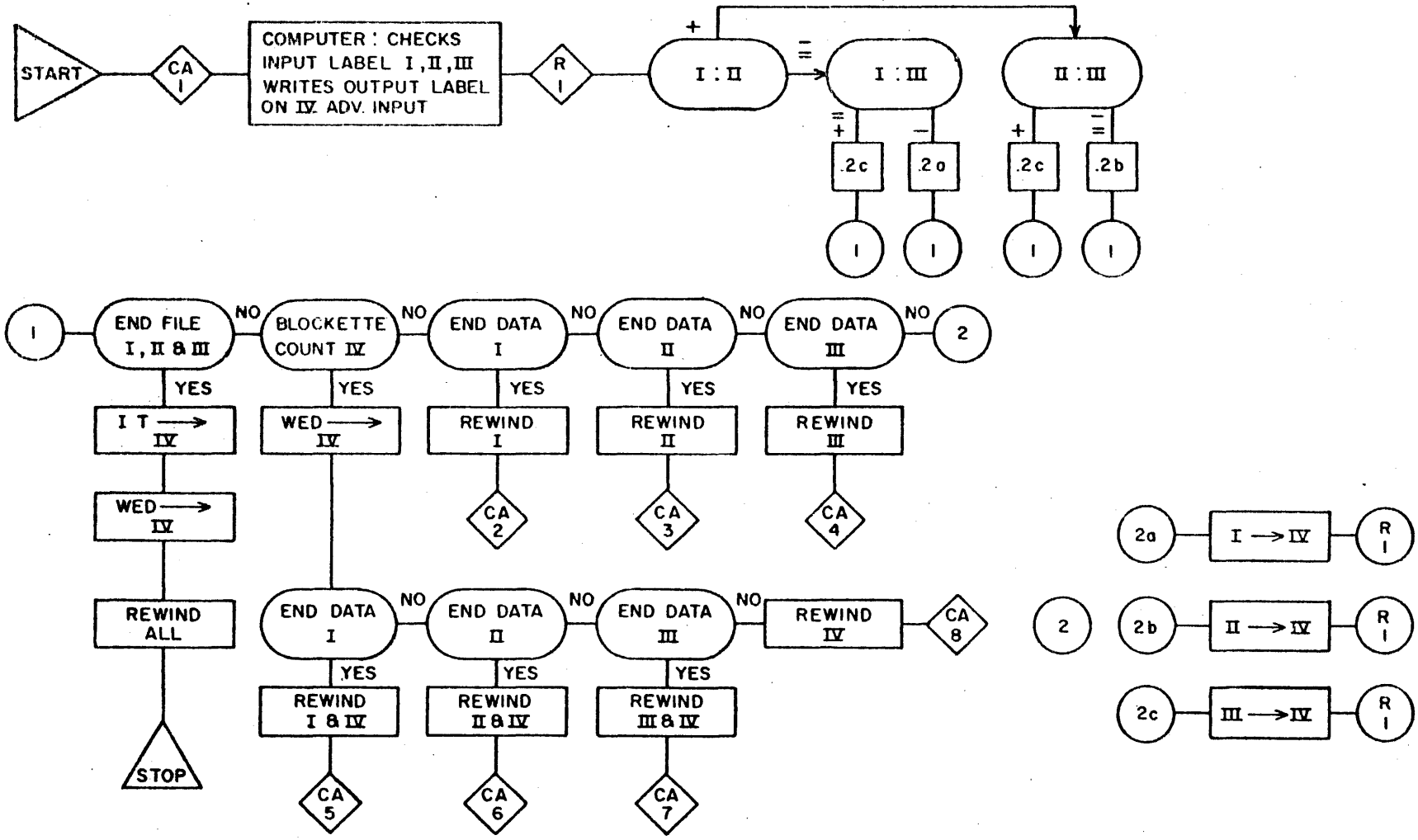


Figure 13. Flow Chart

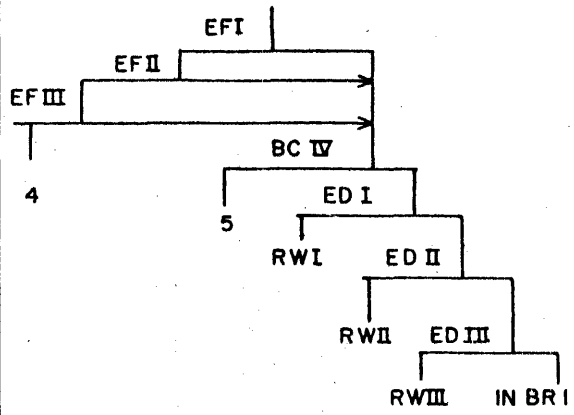
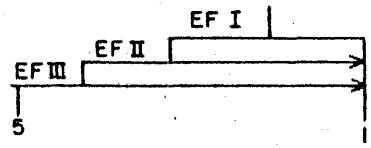
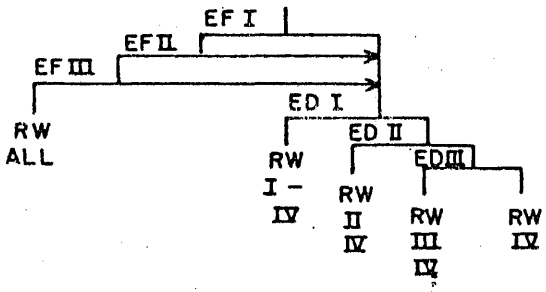
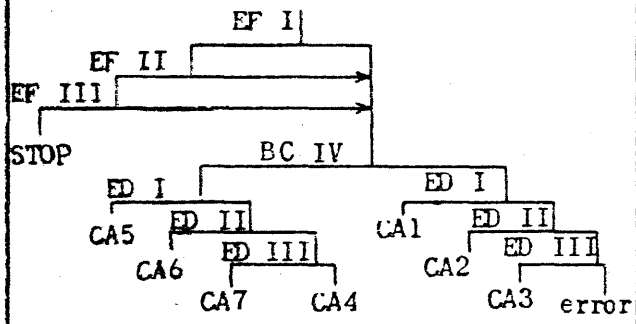
STEP	PROCESS	SOURCE	DESTIN-ATION	OUT OF STEP	COMMENTS
1	C Compare	-	-		Out of the Compare step probe for Terminal Conditions thru a selector chain as pictured. If EF I, II, and III exist the merge is complete - Start exit routine with step 4. If End of Blockette Count on IV go to WED step (#5) If End Data I or II or III go to corresponding Rewind. If no Terminal Condition, go to In of Br 1 to probe results of C.
2	T Transfer	I	IV	to Step 1	Continue Main Routine
3	T Transfer	II	IV	to Step 1	Continue Main Routine
4	T Transfer	III	IV		If EF I, II, and III exist continue exit routine at step 5. Otherwise follow Main routine and go to step 1.
5	WED Write End of Data	-	IV		If EF I, II and III exist continue exit routine-Rewind all MTU's. If ED I, II or III exist it means two terminal conditions are present at the same time. Thus go to Rewind IV plus the Rewind corresponding to the ED MTU. If no EF or ED terminal signals then there is only End of Blockette IV, so Rewind IV.

Figure 14. Program Chart for the Collation Program

START

TO	COMMENT
CA 8	Alert Computer to Handle Labels.

REWIND OUT

TO	COMMENTS
	If End of File I, II, & III, exit routine complete--Stop. If End Blockette Count IV; probe to see if End of Data I, II, or III also exist and pulse appropriate Computer Alert as result. If no End Blockette Count, probe to see which End of Data I, II, or III exists, and pulse appropriate Computer Alert. If no Terminal Condition exists, Rewind was an error.

BRANCHES

#	In From	+	-	=	COMMENTS
1	Out Step 1	In Br 3	In Br 2	In Br 2	Wire the Branches to determine the smallest of I, II, or III. Wire the out so that the smallest is transferred to IV
2	-, = outs of Br 1	Step 4	Step 2	Step 4	
3	+ out of BR 1	Step 4	Step 3	Step 3	

COMPUTER ALERT

NO.	CONDITION	COMMENTS
1	ED I	Computer to check label on MTU I; If OK read in 1st data blockette.
2	ED II	Same as for 1 except for MTU II
3	ED III	Same exc. for MIU III
4	End BC IV	Computer to put label on new output tape on IV
5	ED I & BC IV	Computer to check label on I; put label on IV
6	ED II&BC IV	Same as 5 except for II and IV
7	ED III&BCIV	Same as 5 except for III & IV
8	START	Check labels on I, II, & III. Write correct label on IV

Figure 15. Function Chart

Selector Chains are shown on other charts at their logical position in the program. This chart represents a summary which is used to verify that there are enough Program Selects, Terminal Program Selects, Selectors, and Selector Poles to handle the Selector Chains required.

Condition Requiring Activation	Condition Requiring Drop Out	No.of Poles Required	Selector Assigned	COMMENTS
* EF I	END OF PROGRAM	4	#1	Used to determine when merge complete and to set up exit routine.
* EF II		4	#2	
* EF III		4	#3	
* BC IV	OUT OF RESUME	2	#4	Set up routine for handling full reel on IV.
* ED I	OUT OF RESUME	4	#5	Set up routines for handling empty reels on I, II, or III.
* ED II		4	#6	
* ED III		4	#7	

* All require use of Terminal Program Selects. Therefore, all 7 Terminal Program Selects are used, but no regular Program Selects are used.

Figure 16. Selector Chart

EXTRACT ROUTINE

File II contains the master list of all subscribers to DATA magazine. The record of each subscriber includes in addition to the name and address, the month and year in which the subscription will lapse. The objective is to prepare a list of all subscribers whose subscriptions lapse during the month of October, November, and December, 1957. The following charts are included:

Figure 17 is the Flow Chart

Figure 18 is the Program Chart for the Collation Program

Figure 19 is the Function Chart

Figure 20 is the Selector Chart

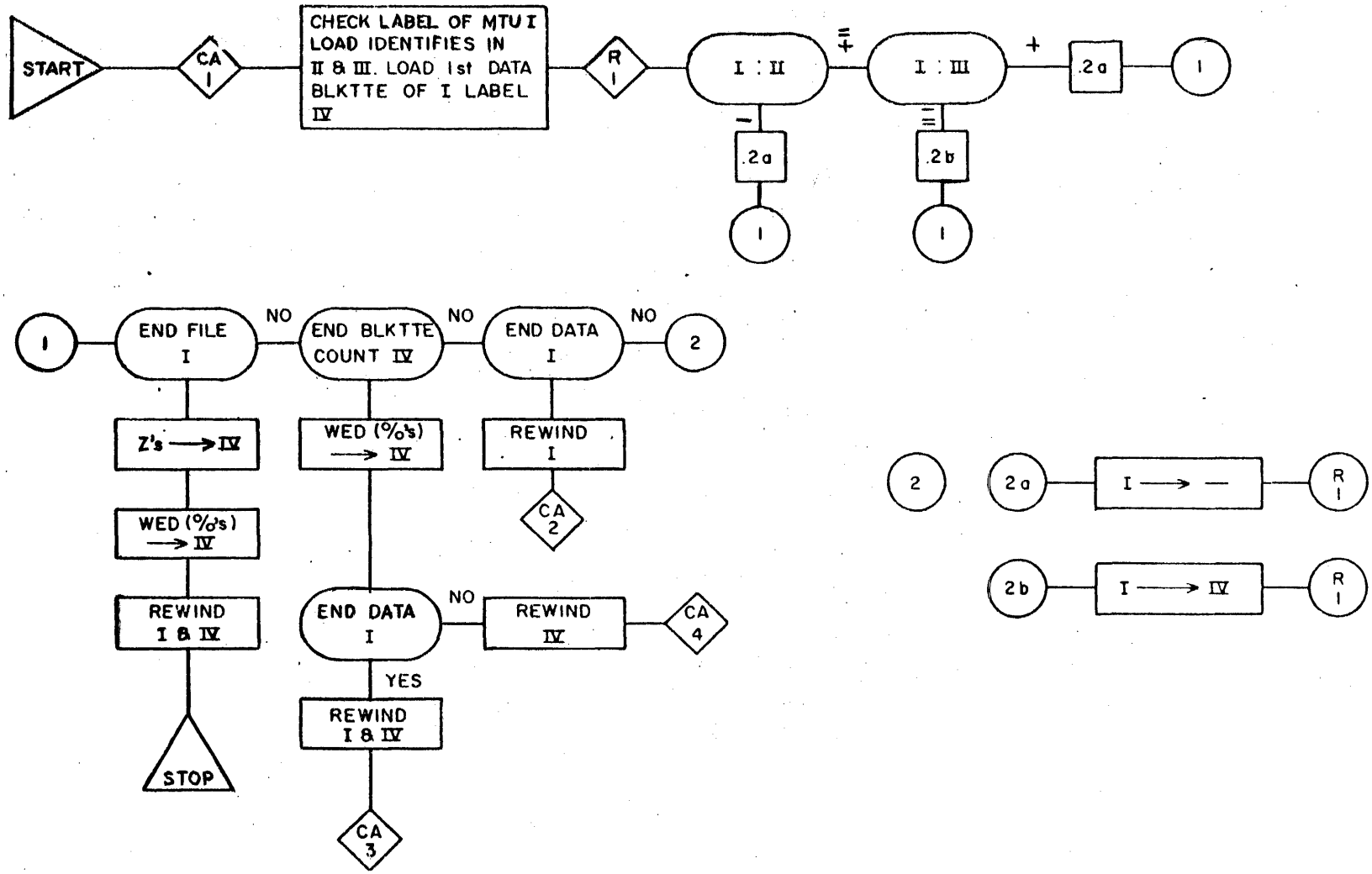


Figure 17. Flow Chart

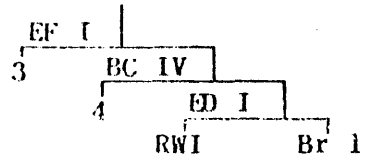
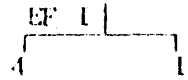
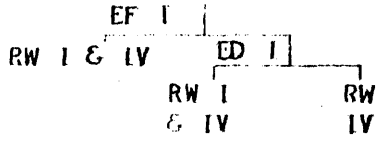
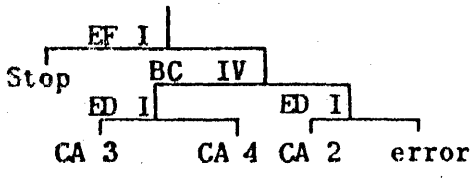
STEP	PROCESS	SOURCE	DESTINATION	OUT	COMMENTS
1	C - COMPARE	--	--		Out of Compare Step probe for terminal conditions as shown in picture of selector chain. If EF I, main routine complete; start exit routine. If BC IV go to step 4 to Write End of Data If ED I go to RWI in preparation for mounting next reel. If no terminal condition go to main routine.
2	T - TRANSFER	I	--	STEP 1	Deletes the Item from the Output Tape (i.e. causes it not to be recorded). Used when the Item is outside the prescribed limits.
3	T- TRANSFER	I	IV		If in exit routine, go to step 4; otherwise follow main routine & go to step 1.
4	WED Write End of Data	--	IV		If in exit routine, Rewind I & IV If in step as result of BC IV, and ED I exist, Rewind I & IV; otherwise Rewind IV.

Figure 18. Program Chart for the Collation Program

START

TO	COMMENT
CA 1	Alert Computer to handle labels and to load identifying limits in II & III

REWIND OUT

TO	COMMENTS
	Out of Rewind probe to see which Terminal Condition(s) initiated the need for Rewind If EF I, exit routine complete - stop. If BC IV & ED I pulse CA 3 If BC IV only pulse CA 4 If ED I only pulse CA 2 If No Terminal Condition Rewind was error.

III

BRANCHES

	In From	+	-	=	
1	Out Step 1 Main Routine	In Br 2	Step 2	Step 3	Wire the branches to determine all cases where II ≤ I ≤ III. In these cases wire to the "in" of step 3 which transfers I to IV. Otherwise wire to step 2 which deletes the Item on I.
2	+ out of Br 1	Step 2	Step 3	Step 3	

COMPUTER ALERT

NO.	CONDITION	COMMENTS
1	START	Computer to check label on I; Load 1st data blockette on I; Transfer identifiers to II & III Buffers
2	ED I	Computer to check label on MTU I; Read in 1st data blockett
3	BC IV & ED I	Computer to check label on MTU I; Read in 1st data blockette Write new label on IV.
4	BC IV	Computer to write new label on MTU IV.

Figure 19. Function Chart

Selector Chains are shown on other charts at their logical position in the program. This chart represents a summary which is used to verify that there are enough Program Selects, Terminal Program Selects, Selectors, and Selector Poles to handle the Selector Chains required.

Condition Requiring Activation	Condition Requiring Drop Out	No. of Poles Required	Selector Assigned	COMMENTS
* EF I	End Prog.	4	#1	Sets up exit routine
* ED I	Out Resume	4	#2	Sets up routine for handling empty reel on MTU I
* BC IV	Out Resume	2	#3	Sets up routine for handling full reel on MTU IV

* All require Terminal Program Selects.
No regular Program Selects required.

Figure 20. Selector Chart

TWO-WAY MERGE WITH SEQUENCE CHECK ON INPUT, OUTPUT TAPE SWAP AND COMPUTER ALERT FOR HANDLING TAPE LABELS

File I is a multi-reel master list of subscribers. File II is the list of new subscribers (may be multi-reel) plus a complete new record of old subscribers with changed records (i.e., new address, renewed subscription, etc.) Merge Files I and II to form a new master list. The following charts are included:

Figure 21 is the Flow Chart

Figure 22 is the Program Chart for the Collation Program

Figure 23 is the Function Chart

Figure 24 is the Selector Chart

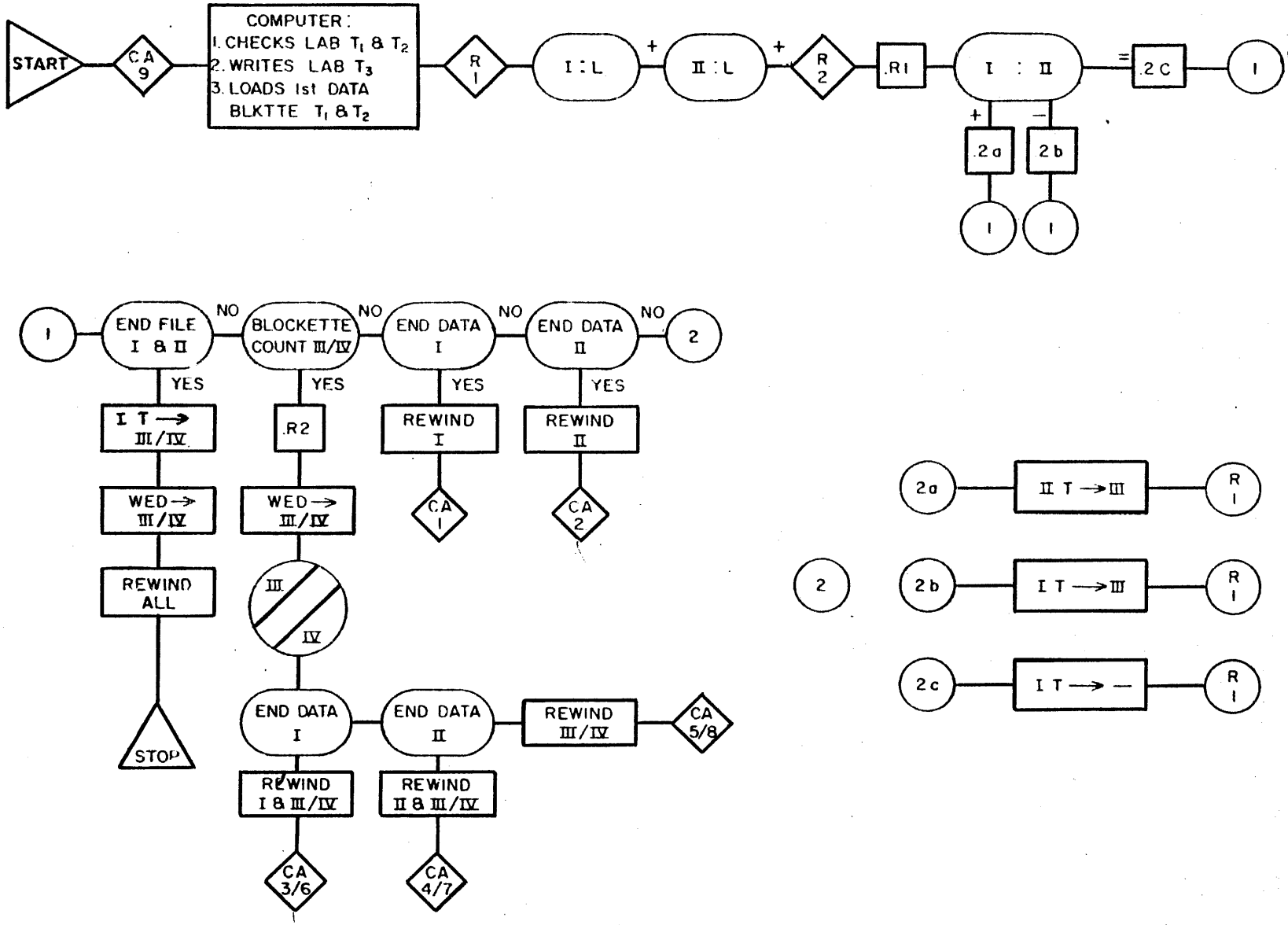


Figure 21. Flow Chart

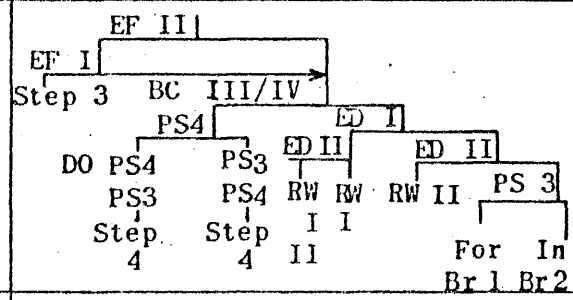
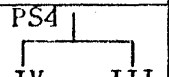
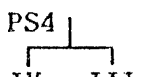
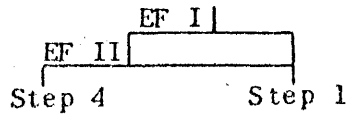
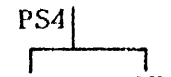
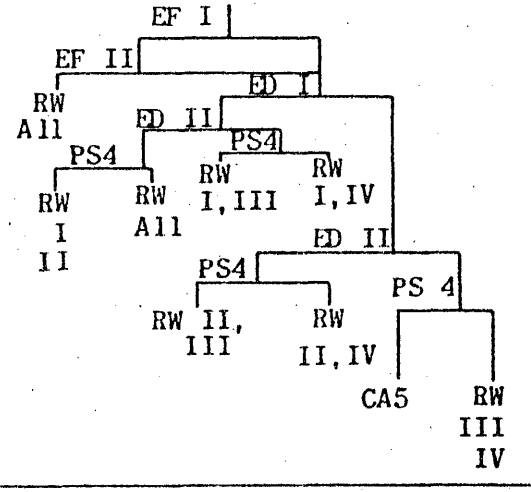
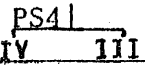
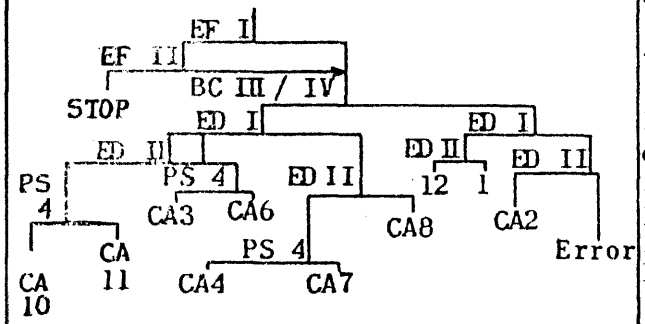
STEP	PROCESS	SOURCE	DEST.	OUT	COMMENTS
1	C-COMPARE	--	--		Out of Compare step probe for terminal conditions. If EF I & II, merge over; start exit routine. If End Blockette Count III or IV, set output tape swap by pulsing Program Select 4 to pick up or drop out. Go to WED step. If ED I or II Rewind corresponding MTU. If no terminal condition follow main routine at 1N of Branch 2.
2	T-TRANSFER	I		STEP 1	Transfers Master Tape Item to New Master Tape. Continue Main Routine.
3	T-TRANSFER	II			Transfers Change Tape Item to New Master Tape. If EF I & II, this step is part of exit routine which copies EF sentinel from MTU II to Output tape.
4	WED-Write End of Data	--			Out of WED step probe to see which terminal condition(s) initiated the need for WED and thereby determine what to do next. If EF I & II, follow exit routine, Rewind all. If ED I(II), two terminal conditions exist simultaneously (EDI(II) & BC); therefore RWI(II) &III or I(II) & IV as appropriate. If End Blockette Count III only; do not Rewind; go immediately to CA5. If End Blockette Count IV only; Rewind III & IV.
5	T-TRANSFER	I	--	STEP 6	Deletes Item from Master Tape. This item is to be replaced on new Master Tape by Item from Change Tape.
6	T-TRANSFER	II		STEP 1	Transfers Change Item which replaces Master Item to new Master Tape.

Figure 22. Program Chart for the Collation Program

START

TO	COMMENT
CA 9	Alert Computer to Handle Labels.

REWIND OUT

TO	COMMENTS
	Out of Rewind, probe to determine what initiated the need for rewind and thereby determine what to do next. If EF 1 & II-exit routine complete-Stop If BC & EDI(II) go to CA3(4)or CA6(7) depending on Tape Swap condition. If BC & EDI, II go to CA 10 If BC only go to CA8 If ED 1 (II) go to CA 1(2) If ED 1,II go to CA 11 If no terminal condition - error.

BRANCHES

#	In From	+	-	=	COMMENTS
1	Out + Br 3	Step 3	Step 2	Step 5	Determine which Item is to be transferred to Output Tape.
2	Main Prog Out Step 1	In Br 3	Error	Error	Performs sequence check on MTU I.
3	Out + Br 2	In Br 1	Error	Error	Performs sequence check on MTU II

Figure 23. Function Chart

COMPUTER ALERT

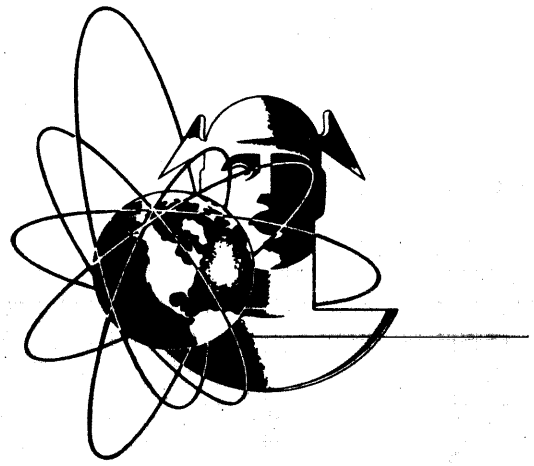
NO.	CONDITION	COMMENTS
1	ED I	Computer checks label MTU I.
2	ED II	Computer to check label MTU II.
3(6)	BC III(IV)+ ED I	Computer to check label MTU I. Write label on MTU III(IV)
4(7)	BC III(IV)+ ED II	Same as 3 except MTU II
5	BC III	Computer Write label on MTU IV.
8	BC IV	Computer Write label on MTU III.
9	START	Computer to check label on MTU I & II, Write label on MTU III
10	BC III, ED I ED II	Computer to check label on MTU I & II. Write label on IV.
11	BC IV, ED I & ED II	Same as 10 except write on MTU III.
12	ED I & II	Computer to check label on MTU I & II.

Selector Chains are shown on other charts at their logical position in the program. This chart represents a summary which is used to verify that there are enough Program Selects, Terminal Program Selects, Selectors, and Selector Poles to handle the Selector Chains required.

Condition Requiring Activation	Condition Requiring Drop Out	No. of Poles Required	Selectors Assigned	Comments
* EF I * EF II	END OF PROGRAM	4 4	1 2	Used to determine when merge complete & to set up exit routine.
* ED I * ED II	OUT RESUME OUT STEP 6	5 9	3,4 5,6,7	Set up routine for handling Empty reels on MTU I & II
*BC III/IV	OUT RESUME	2	8	Set up routine for handling full reel on output tape.
PS 3	OUT STEPS 2, 3, 5	1	9	Eliminates Sequence Check on 1st Compare after Terminal Cond
PS 4	OUT STEP 1	11	10,11,12	Handle Tape Swap

* **These require Terminal Program Selects**

Figure 24. Selector Chart



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