UNIVAC®

FILE-COMPUTER
DATA AUTOMATION SYSTEM

MAGNETIC TAPE
INPUT-OUTPUT

Remington Rand Univac

PROGRAMMER'S REFERENCE MANUAL

UNIVAC FILE-COMPUTER

M A G N E T I C   T A P E   U N I T

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

NOTE: The discrepancy between the name on the cover, Magnetic Tape Input-Output, and the name used in the contents of the publication, Magnetic Tape Unit, is due to the change in standard terminology which became effective in June 1958. Since these manuals were written prior to that date, the old terminology is still used in the body of the manual, but it was possible to change the cover to conform to the new terminology.

INTRODUCTION

The File-Computer

The Univac File-Computer, the medium-sized member of the Remington Rand family of electronic computers, is distinguished by its building-block versatility. A central computer may be combined with 1 to 10 large-capacity, random-access storage drums, at the present time, and from 1 to 10 input-output units.

Input-Output Devices

Each of the input-output devices is designed for a specific purpose; any one or all of them may be added to the computer to accomplish desired applications.

Perhaps the most important feature of the input-output units is their ability to share operating time with the storage drums and the central computer so that all may operate simultaneously under control of a single program. An instruction to an input-output unit or instructions to several units may be initiated without causing delay in the computer's execution of logical or arithmetic operations. A program from any source is therefore available in the operating memory of the computer at any required time, and all data processed by the program are either stored or sent to an output device.

One of the most useful of the input-output devices is the Magnetic Tape Unit. This manual describes the operation of this unit and contains programming features, instructions, and techniques, together with other pertinent information.

The Univac File-Computer Magnetic Tape Unit is a multipurpose magnetic tape device which can be included in any Univac File-Computer installation. Its fundamental purpose is to read, record, and variously position Mylar[1] magnetic tape.

It is the tape-handling device both for the computer and for UFC peripheral equipment using magnetic tape. In the Univac File-Computer System, several uses are made of this equipment: (1) it is an input-output unit for the computer; (2) it is an integral part of the Sort-Collate System; (3) it is a data source for off-line (externally controlled) operation of the High-Speed Printer.

The Univac File-Computer Magnetic Tape Unit is an on-line (computer controlled) device: its operations are controlled by a computer or peripheral equipment program. However, except during intervals in which control information is exchanged, the computer and the Magnetic Tape Unit operate independently; that is while the MTU is executing the operations comprising its instruction, the computer can also be executing instructions in its program.

---

[1] Registered trade mark of Dupont Co.

Input-Output Medium

Mylar magnetic tape is the medium employed in this device. The Mylar base is oxide coated and data are recorded by magnetizing minute spots on this coated surface. Each spot is given one or the other of two polarities; accordingly, the two different and separate polarities have the connotation of a "1" or a "0". Reading is accomplished by sensing these recorded spots.

Data are recorded and read a line at a time. One standard Univac seven-bit computer character is stored on each line. In Read and Write operations a Magnetic Tape Unit processes 120 consecutive lines or characters before the tape stops. The basic format of the tape unit is a grouping of 120 characters, called a "blockette".

Physical Tape Specifications

Width: 1/2"

Base: 1 1/2 mil Mylar

Recording Density: 139 lines per inch in blockette format with 0.5 in. or 1.0 in. between blockettes.

Block Spacing (Univac I and II Mode only):   2.4 in. between blocks (1 block = 6 blockettes).

Blockette Length: 120 characters recorded at a density of 139 lines (characters) per inch, make a blockette 0.86 in. in length.

Reading Density: The Magnetic Tape Unit will read information recorded at a density of from 50 lines per inch to 160 lines per inch.

Standard Lengths: 2400 ft. on a 10½" reel.
                    400 ft. on a 6" reel.
                    300 ft. on a 6" reel.[1]

Number of Blockettes Per Reel:

	LIMIT OF AUTO-MATIC COUNT	2,400' REEL SAFE MAX.
1/2" BLOCKETTE SPACING	20,000 BLOCKETTES	20,300 BLOCKETTES
UNIVAC I & II MODE SPACING	2,350 BLOCKS	2,400 BLOCKS

---

[1] This reel is equipped with bumpers and leaders and is for use only in joint Univac File-Computer and Univac I or II installations.

The UFC Magnetic Tape Unit, in addition to handling tape physically and reading and writing data on the tape, detects terminal conditions which are the result of certain commands. These terminal conditions are described later under "Special Features".

It is recommended that in addition to meeting the physical tape specifications as listed above, the input data be recorded in the programming format described below.

File and Item

The principle programming unit is the "file". A file is composed of a group of contiguous items. Each item is a collection of consecutive characters that form a major file entry. Items regardless of size are physically recorded in blockette format. Depending on the requirements of the program, an item may be one blockette in length (120 characters), it may be several blockettes in length, or more than one item may be contained in one blockette.

As an example, in a payroll problem, certain specified information such as clock number, name, and rate of pay, about all employees would compose a file whereas this same information about one employee would compose one item in the file. Any given field of information, such as employee clock number, should be located in the same relative position in every item in the file. The first item of every file and of every reel of a file should be an identifying label. The label should identify the file, list the reel sequence number in the file, and record the date when this edition of the file was created. Additional information can be included if the programmer so desires. More detail on tape labeling is included in "Programming Techniques".

The last item of every file should be a sentinel item which contains the end-of-file sentinel automatically detected by the Magnetic Tape Unit circuitry. This sentinel is at least one full word of Z's. The word "sentinel" in this manual is defined as a symbol marking the beginning or the ending of a file or unit of data.

The item following the last valid file item on a tape should be a sentinel item which contains the end-of-data sentinel automatically detected by the Magnetic Tape Unit circuitry. This sentinel is at least one full word of %'s.

When a tape is to be used in "Tape Search<>" operation, and when the items on this tape are multiblockette items, the most significant character position of every blockette in the item should contain a "Search Validation Character". The character position to be treated as the Search Validation Character by a given MTU can be selected by a switch on a panel of the MTU. It may be either the most significant digit or the least significant digit of the blockette. In this manual, the Search Validation Character is considered the most significant digit position for the sake of clarity in discussion. (See "Search Validation Character" later.)
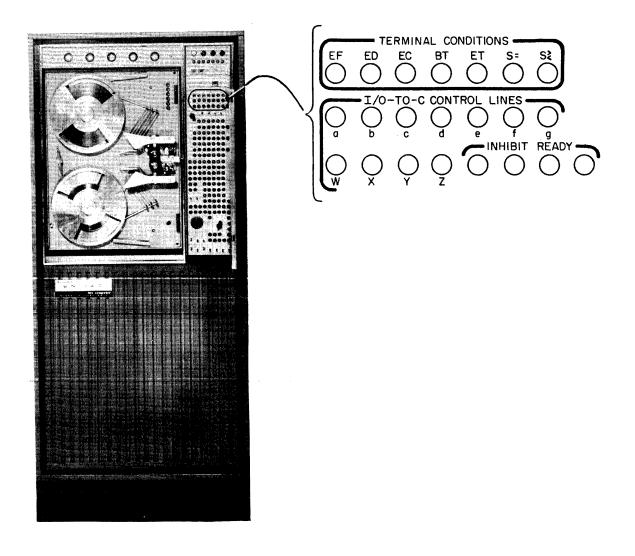
3

FIG. I
MAGNETIC TAPE UNIT

The receipt of any instruction by the UFC Magnetic Tape Unit will cause the MTU to perform a series of operations including examination of tape for the detection of terminal conditions important to programming. [T]hese seven terminal conditions are listed below.

Beginning of Tape and End of Tape

These conditions are photoelectrically sensed as transparent areas at the beginning and end of the tape. When either Beginning of Tape or End of Tape is detected, a signal is sent out to an appropriately labeled hub (BT, ET) on the control panel (see Fig. 1) of the tape unit.[1] Further movement of the tape is then prohibited for any direction other than forward for a Beginning of [T]ape condition and backward for the End of Tape condition.

Automatic Sentinel Detection: End of File (EF), End of Data (ED)

Information passing from the magnetic tape to the tape unit buffer is scrutinized for end of data (ED) and end of file (EF) sentinels. (See Fig. 3, in "Instruction Repertoire.") When a sentinel condition is detected (End of File equals one word of Z's; End of Data equals one word of %'s), a signal is sent to the appropriate hub on the control panel of the tape unit. (See Fig. 1)

Automatic Blockette Counting and Checking

Whenever there is tape movement and a blockette passes the Read-Write Head, the blockette counter is increased or decreased by 1 depending on the direction in which the tape is moving. The count is then automatically compared against a preset limit (two choices are available by dial selection on the control panel: 20,000 blockettes for UFC mode; 2,350 blocks for Univac I and II mode), and a signal is sent to the appropriately labeled hub (EC, see Fig. 1) on the control panel when the limit is reached. (This signal, too, like those previously mentioned may be used to notify the computer of the conditions existing in the MTU.) The purpose of this counter is to give warning of the approaching end of the tape, particularly during the writing operation, so that measures can be taken to prevent writing off the end of tape.

Note: The above functions of the tape unit automatically occur without any special action on the part of the progra~mer or operator; these functions require no computer (or peripheral device) time. If a condition arises that may require variation of the computer (or peripheral device) program, a signal is provided on the control panel (or to the peripheral device control circuitry) by which the necessary action can be initiated.

Tape Search

A unique feature of the UFC MTU is its ability to search a tape for a specified record without engaging central computer time. The computer specifies which record is desired and initiates the search with an instruction to the MTU. The

---

[1] These signals may be utilized (if the programmer so desires) to notify the computer of the conditions existing in the MTU.

MTU then automatically checks the records on its tape until it locates the de-
sired record or detects a stopping sentinel. When a specified record is located,
a "find" is said to have occurred. The record found is deposited on the I/O
track and a signal is sent to an appropriately labeled hub on the control pan-
el of the tape unit. (This signal, too, may be used to notify the computer of
the conditions existing in the MTU.)

The Search Validation Character establishes the position of the blockette in the
item (i.e., the first, fifth, etc.) and allows the search to be made on speci-
fied character positions in a multiblockette item.

The Search Validation Character must be in the most significant position in Tape
Search <> operations. The circuitry of the UFC Magnetic Tape Unit is so designed
that the most significant character position of a blockette is handled separate-
ly in tape search operations. For a find to occur, the character in this posi-
tion must be identical to the corresponding character in the identifier (un-
less comparison is suppressed by an ignore code in the identifier).

An example will illustrate the need for a Validation Character. (A Validation
Character is needed in Tape Search = operations (S =, see Fig. 1) as well as in
Tape Search $\geqslant$ operations (S $\geqslant$, see Fig. 1), but the positioning of the Valida-
tion Character is not critical in Tape Search = operations since every character
position being compared with the identifier must be equal for a find to occur.)
Assume we have a Master Payroll File with all items 10 blockettes in length. The
items are arranged in order of increasing clock numbers.

1. The item design is such that the employee clock number is in
   blockette 1, word 2, character positions 4, 3, 2, 1, and the
   FICA withheld to date is in blockette 6, word 2, character
   positions 4, 3, 2, 1. Note that the positions of these two
   fields are the same within their respective blockettes. Now
   assume that a search forward = instruction is given in order
   to locate the record for employee 3871.

2. Assume also that employee 1078 has had FICA withheld to date
   of 3871.

3. If we merely load 3871 in word 2, character positions 4, 3,
   2, 1, of our identifier, we will find the record for employ-
   ee 1078 instead of employee 3871, and in addition we will be
   in blockette 6 of that record instead of blockette 1.

Therefore, in order for the correct and desired information to be found, a Vali-
dation Character must be in the most significant character position in each
blockette of the 10 blockette item and also in the most significant character
position of the searching identifier.

Tape Search on 60-Character Items

Tape Search can be done on items of 60 characters in length ($\frac{1}{2}$ blockette). The
two position toggle switch (designated item length) located on the MTU panel is
manually set to the "60" position instead of the "120" position as in normal
tape search.

6

Two items, each 60 characters in length, are stored in each blockette on the tape. Accordingly, the 120 identifier positions are divided into two parts: the words 0, Character 11 through word 4, Character S, are used for the first Item; and Words 5, Character 11 through word 9, Character S, are used for the second Item. Word 0, Character 11 is the most significant identifier position for the first item in the blockette; and Word 4, Character S is the least significant identifier position for the first item in the blockette. Word 5, Character 11, is the most significant identifier position for the second item in the blockette; and Word 9, Character S is the least significant identifier position for the second item in the blockette. When 60-character items are used in any Tape Search operation, (a) all items in each file involved must be 60-character items, and (b) both halves of the Identifier Position must be identically loaded. (See Fig. 12.)

Inhibit Ready

The Inhibit Ready hubs (see Fig. 1) are receiving hubs that may be jackplug patched from terminal condition hubs to prevent a ready status of the tape unit when a terminal condition is detected. Consequently, when the Magnetic Tape Unit recognizes a terminal condition, it will be inhibited from going "ready" when the execution of the previous instruction is complete, and will remain in a "not-ready" status. (See "Communication with Computer.") Inhibit Ready hubs are used mainly by maintenance engineers in testing the tape unit, but may be used by programmers as an added safety factor.

Tape Perfection Guarantee

It is possible to mark any unusable areas on a UFC tape so that the MTU will automatically avoid reading or writing on these areas. An unusable area is marked by punching holes in a tape at the beginning of an area and at every 2½ inches thereafter until the end of the bad spot is reached. (Ordinarily, the programmer need only be convinced that bad spots are detected and corrected; the engineer or the operator will accomplish the actual detection and correction.) The holes denoting bad spots are photoelectrically detected by the MTU. When a UFC tape comes from the factory it is 2572 feet in length. If after repeated usage a tape imperfection appears in the tape, the bad spot may be marked as described above without reducing the effective length of the tape (considered to be 2400'). The "Tape Perfection Guarantee" method utilized by the UFC MTU eliminates problems entailed in handling small lengths of salvaged tape.

Removable Take-Up Reel

If the first operation to be performed is "Read Forward" or "Write," the tape to be processed must be placed on the Supply Reel (the upper reel of the tape handler; see Fig. 1). If the first operation is to be "Read Backward," the tape to be processed must be placed on the Take-Up reel (the lower reel of the tape handler). The Take-Up reel is removable. The Wind Forward with Interlock command (see "Instruction Repertoire") is used when the programmer wishes to remove the Take-Up reel in a wound condition. The wound processed reels of tape may be rewound later on an off-line basis. Off-line rewinding can be performed on any UFC Magnetic Tape Unit when tape unit time is available, but it must be remembered that no checking will occur during an off-line rewind operation (see "Rewind" in "Instruction Repertoire"). Checking of the output tape may be secured, however, by the use of the "write and check" command (see "Instruction Repertoire").

INSTRUCTION REPERTOIRE

The Univac File-Computer Magnetic Tape Unit can execute the thirteen input-output instructions listed in Table I. A description of each instruction follows Table I.

TABLE I

MAGNETIC TAPE UNIT INPUT/OUTPUT INSTRUCTIONS

INSTRUCTION	ACTIVATING C-TO-I/O LINE(S)	* CODE FOR V ADDRESS
READ FORWARD	A	556
SEARCH FORWARD =	B	557
SEARCH FORWARD = OR >	AB	558
WIND FORWARD WITH INTERLOCK	AC	559
WRITE	BC	553
WRITE & CHECK	ABC	554
TRANSFER BUFFER TO TRACK	D	565
READ BACKWARD	AD	566
SEARCH BACKWARD =	BD	567
SEARCH BACKWARD = <	ABD	568
REWIND	DC	569
REWIND WITH INTERLOCK	ADC	562
TRANSFER TRACK TO BUFFER	ABCD	564

* CODE WHICH CAN BE USED IN THE V PORTION OF THE "DEMAND" INSTRUCTION TO ACTIVATE THE DESIGNATED C-TO-I/O LINE(S). A COMPLETE DESCRIPTION OF HOW THIS CODE IS DERIVED IS GIVEN IN THE UFC MODEL I PROGRAMMING MANUAL.
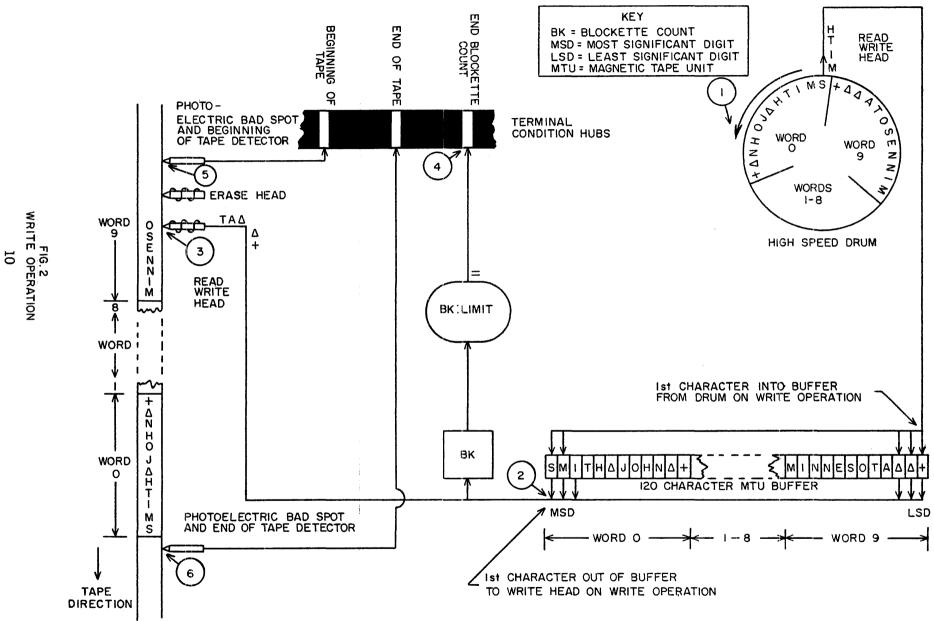
Write

Write operations require that the data to be recorded has been previously loaded by the computer program on the input-output track connected to the Magnetic Tape Unit. Writing on Tape, unlike reading, can be done only in a forward direction. (See "Read Forward" and "Read Backward" for the two-way "reading operations".)

When the Magnetic Tape Unit receives a write instruction, the following sequence of events takes place.

1. Information recorded on the input-output track of the high-speed drum (see Fig. 2 ①) is duplicated in the Magnetic Tape Unit Buffer. Information is read from the high-speed drum sequentially, beginning with the least significant digit (LSD) of word 9 and continuing to the most significant digit (MSD) of word 0, and flows into the buffer in that order. The new data flowing into the buffer (see Fig. 2 ②) replace any old information in the buffer.

2. Flowing out of the buffer to be recorded on the tape, the information is transmitted from most significant digit to least significant digit. Thus the information is eventually recorded on the tape in the same order as it would have been if it had been typed.

3. From the buffer, the information flows through various circuitries to the Read-Write Head (see Fig. 2 ③). The blockette counter, which is set to zero by master clear or by rewinding, advances once for every write operation. After each increment, the number stored in the counter is compared with a specified limit, and when the count equals this limit, a signal is sent to the appropriately labelled hub on the control panel of the Magnetic Tape Unit (see Fig. 2 ④). This signal can be used to activate one of the Input-Output computer control lines and thus eventually be used to vary the computer program (see section on "Communication with the Computer").

4. The Write Head (see Fig. 2 ③) records the data on the magnetic tape one line (character) at a time at a density of 139 lines per inch. This is a one-blockette operation; i.e., 120 characters are transferred from the high-speed drum to the Magnetic Tape Unit buffer and 120 characters are transferred from the buffer onto the magnetic tape.

5. An erase head, which is located $2\frac{1}{2}$ inches in front of the Read-Write head, operates in conjunction with the write operation to erase old recordings from a previous program. (See Fig. 2 ⑤.)

For checking on the accuracy of data transmission in this and all following tape instructions, except "Wind Forward with Interlock", see "Timing and Checking" sections.

FIG. 2
WRITE OPERATION
10

KEY
BK = BLOCKETTE COUNT
MSD = MOST SIGNIFICANT DIGIT
LSD = LEAST SIGNIFICANT DIGIT
MTU = MAGNETIC TAPE UNIT

HIGH SPEED DRUM

READ WRITE HEAD

WORD 0
WORD 9
WORDS 1-8

TERMINAL CONDITION HUBS

BEGINNING OF TAPE

END OF TAPE

END BLOCKETTE COUNT

PHOTO-ELECTRIC BAD SPOT AND BEGINNING OF TAPE DETECTOR

ERASE HEAD

READ WRITE HEAD

TAΔ

BK LIMIT

BK

PHOTOELECTRIC BAD SPOT AND END OF TAPE DETECTOR

1st CHARACTER INTO BUFFER FROM DRUM ON WRITE OPERATION

| S | M | I | T | H | Δ | J | O | H | N | Δ | + | | | M | I | N | N | E | S | O | T | A | Δ | Δ | + |

120 CHARACTER MTU BUFFER

MSD

LSD

WORD 0 — 1-8 — WORD 9

1st CHARACTER OUT OF BUFFER TO WRITE HEAD ON WRITE OPERATION

WORD 9

WORD 1

WORD 0

TAPE DIRECTION

Write and Check

When the Magnetic Tape Unit receives the Write and Check instruction, a sequence of events takes place.

1. The 120 characters on the high-speed drum input-output track (see Fig. 2①) which is connected to the Input-Output unit are transferred to the Magnetic Tape Unit Buffer.

2. Data from the buffer flows through various circuitries to the Read-Write Head and is recorded on the magnetic tape.

3. The tape then reverses direction and passes back under the Read-Write Head and the 120 characters just written are now read.

4. This information flows from the Read Head to the tape unit comparator (the comparator shown in Fig. 4⑤) one character at a time, at the same time that the corresponding character is coming to the comparator from the tape unit buffer.

5. If the 120 characters compare as being equal, then the tape is repositioned so that the Read-Write Head is at the end of the blockette just written.

6. If the tape and buffer blockettes are not identical, a second attempt is made to execute the instruction, starting with the transfer of the data from the input-output track to the MTU buffer. The circuitry of the unit is so designed that destructive Write is possible for one blockette.

7. If this second attempt is satisfactory, the tape unit stops and the tape is in the correct position for writing the next blockette.

8. If the comparison is still unsatisfactory, a third attempt is made to execute the instruction.

9. If this attempt at comparison fails, an error is indicated, the MTU stops in a "not ready" condition, and the appropriate error light on the control panel comes on.

Recovery from this and other errors is discussed in the section on "Programming Techniques". Whenever tape movement is initiated, as required to execute the write and check instruction, the blockette counter is increased or decreased one blockette depending on the direction of the tape movement.

Read Forward

When the Magnetic Tape Unit receives the Read Forward instruction, a sequence of events takes place.

1. The tape unit starts the magnetic tape moving past the Read Head (see Fig. 3①) in a forward direction. One blockette of 120 characters is read one character at a time, and the information flows through various circuitries into the tape unit buffer.

2. During this time, the end of data sentinel checker (see Fig. 3②) scrutinizes the data to see if there are twelve percent (%) signs in any word of the ten words in the blockette being read. If there is at least one word of percent signs, the end of data checker sends a signal to the appropriately labeled hub on the Magnetic Tape Unit control panel. This signal can be patched to an I/O-to-C control line and can eventually be used to vary the computer program.

3. The end of file sentinel checker (see Fig. 3③) scrutinizes the data to see if there are 12 Z's in any word of the ten words in the blockette being read. If there are 12 Z's in any word, a signal is sent to the appropriately labeled hub on the Magnetic Tape Unit control panel. This signal can be wired to an I/O-to-C control line (either high-speed or low-speed) and eventually used to vary the computer program.

4. During execution of each Read Forward instruction, the blockette counter is automatically increased by one. The blockette counter is then automatically compared with a prescribed limit, and when this limit is reached, a signal is sent to the appropriately labeled hub on the Magnetic Tape Unit control panel. This signal may be wired to an I/O-to-C control line (either high-speed or low-speed) and used to vary the computer program.

Note: If more than one sentinel condition results from the processing of one blockette, a signal will be received at each of the appropraitely labeled hubs on the control panel; i.e., if one word of a blockette is composed of 12 Z's, another word of twelve % signs, and the blockette is the 20,000th one on the tape, signals will be sent to each of the sentinel hubs: End of Data, End of File, and End of Blockette Count.

5. Going into the Magnetic Tape Unit buffer, the data are read from the tape from the most significant digit to the lease significant digit and flows through the system in that order. In leaving the buffer it flows out lease significant digit of word nine first, and flows to the read-write head of the high-speed drum (see Fig. 3④) where it is written on the input-output track connected to the Magnetic Tape Unit.

Read Backward

When the Magnetic Tape Unit receives a Read Backward instruction, the following sequence of events takes place.
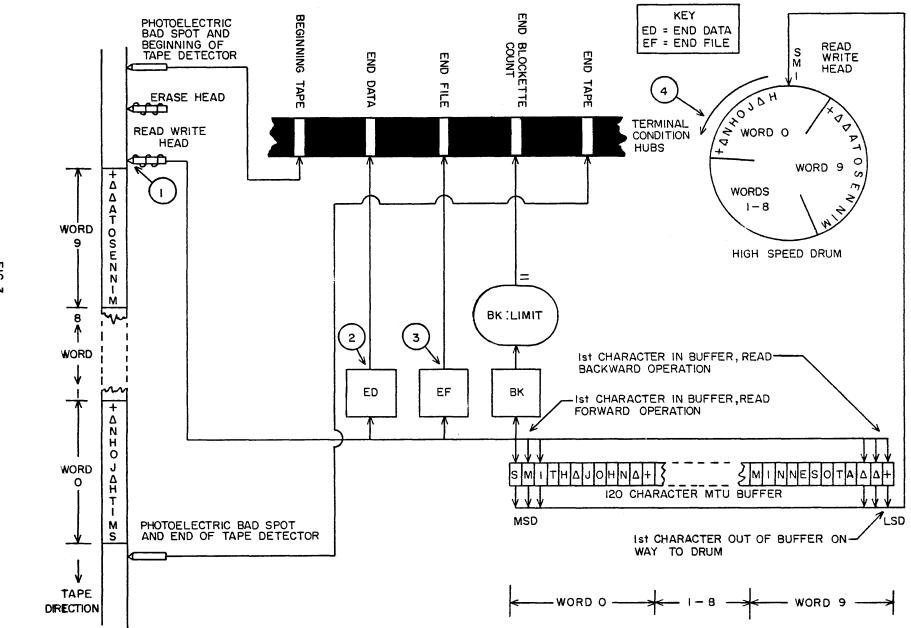
FIG. 3
READ OPERATION
13

The tape starts moving in a backward direction past the read head, and 120 characters are read from the tape and transferred through various circuitries into the Magnetic Tape Unit buffer. The first character read is the least significant digit of word nine, and the characters are read consecutively from that character to the most significant character of word zero. Information flows into the Magnetic Tape Unit buffer in reverse order; at the end of the process the relative position of information in the buffer is the same as if the process had been a read-forward instruction. All other features of this operation, including the automatic sentinel detection, are the same as in the read-forward instruction.
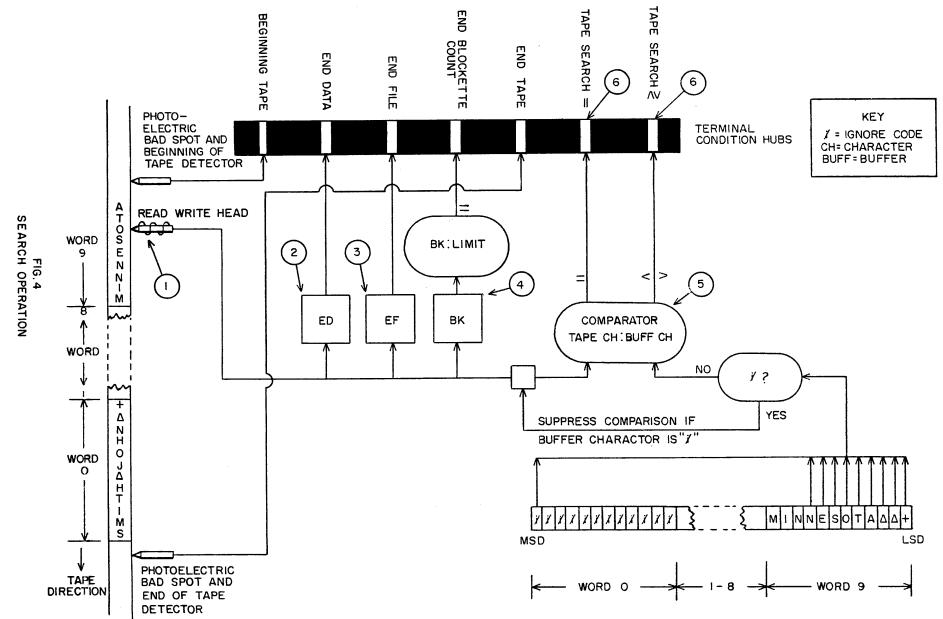
Search Forward Equal

Search operations require that an identifier has previously been loaded on the input-output track connected to the Magnetic Tape Unit. (See section on "Programming Technique" for discussion on identifier.)

During a search forward equal operation, a definite sequence of events takes place.

1. The identifier loaded on the input-output track connected to the input-output unit is read and transferred into the Magnetic Tape Unit buffer.

2. The magnetic tape begins moving in a forward direction past the read head, and the characters are read one at a time as they pass the read head (See Fig. 4 ① .)

3. The tape data are scrutinized by the end of data sentinel checker (see Fig. 4 ②) and by the end of file sentinel checker (see Fig. 4 ③); and for each blockette read from the tape, the blockette count is increased by 1 and this accumulation is compared against a limit previously set by dial selection on the control panel (see Fig. 4 ④).

4. Data flow through various circuitry into the Magnetic Tape Unit comparator (see Fig. 4 ⑤). As each character arrives at the comparator, the corresponding character arrives from the Magnetic Tape Unit buffer. When the comparator finds 120 characters within a blockette from tape which are equal to the 120 characters stored in the Magnetic Tape Unit buffer, a signal is sent to the appropriately labeled hub on the control panel of the Magnetic Tape Unit (see Fig. 4 ⑥).

Note: If ignore codes are part of the identifying information stored in the Magnetic Tape Unit buffer, comparison is suppressed; in effect, any tape character will compare as equal to an ignore code in the same relative position in the buffer. This ability of the ignore code to suppress comparison allows the identifying field of the blockette to be from 1 to 120 characters in length, and in any position or positions in the blockette.

5. When the Search Forward Equal find occurs, the least significant digit of the blockette has passed the read head and the magnetic tape

14

FIG. 4
SEARCH OPERATION

15

KEY
ɣ = IGNORE CODE
CH = CHARACTER
BUFF = BUFFER

stops. The tape then starts moving in a backward direction past the read head, and 120 characters of the find are now read backward into the Magnetic Tape Unit buffer. The information in the buffer is transferred out and written onto the high-speed drum I/O track connected to the MTU. The tape is now repositioned so that the read head is at the end of the blockette just found, so that the next search will start with the next blockette on the tape.

6. If an "End of Data" or "End of File" sentinel is detected before a find occurs, the tape movement stops at the end of the blockette in which the sentinel was detected. Note that the identifier is still in the Magnetic Tape Unit buffer and on the input-output track of the high-speed drum. The read head of the tape unit is at the end of the blockette in which the sentinel was detected.

Search Backward Equal

The sequence of events in the Search Backward Equal operation is exactly the same as that in search forward equal, except that the direction of tape movement and direction of buffer reading are reversed.

Search Forward Equal or Greater Than

In the Search Forward Equal or Greater Than operation, the sequence of events is the same as in search forward equal except that the comparator is looking for an item on the tape which is greater than the identifier in the buffer as well as one equal to it. In addition, the most significant character position of the blockette is handled differently from the other positions. This position contains the Search Validation Character, and the character from the tape must be equal to the character from the identifier stored in the buffer for a find to occur. If no comparison of the MSD position is necessary, an ignore code is placed in the identifier in the MSD position. The "greater than" portion of the instruction does not apply to the Search Validation Character.

Another difference between the Search Forward Equal or Greater Than operation and the Search Forward Equal operation is that the tape is not repositioned when a find occurs on a Search Forward Equal or Greater Than operation. The read head is at the beginning of the blockette just found so that the next Search Forward Equal or Greater Than operation will start with the blockette just found on the tape.

If a find occurs, it can be distinguished as an equal or greater-than find by the signal which is sent to the appropriately labeled hub on the control panel of the Magnetic Tape Unit.

Search Backward Equal or Less Than

The sequence of events in the Search Backward Equal or Less Than operation is the same as that in Search Forward Equal or Greater Than except that the direction of tape movement and direction of buffer reading are reversed, and the com-

parator checks for an item on the tape equal to or less than the value of the identifier in the buffer. Note: A tape search operation may be accomplished in the same way as above for items that are 60-characters in length when the following conditions are met (1) the two-position toggle switch is set manually to the 60-character position, and (2) both halves of the identifier position are identically loaded in the blockette.

Transfer Buffer Contents To Input-Output Track

When the "Transfer Buffer Contents to Input-Output Track" instruction is sent to the input-output unit, the information in the Magnetic Tape Unit buffer is reproduced on the input-output track connected to the Magnetic Tape Unit. No tape movement is involved in this instruction.

Transfer Input-Output Track Contents To Buffer

When the Magnetic Tape Unit receives the Transfer Input-Output Track Contents To Buffer instruction, the information on the input-output track connected to the Magnetic Tape Unit is reproduced in the Magnetic Tape Unit buffer. No tape movement is involved in this instruction.

Wind Forward With Interlock

When the Magnetic Tape Unit receives this instruction, tape movement begins in a forward direction and continues until the End of Tape is detected. Further tape movement is then inhibited until the interlock is manually released on the control panel of the MTU.

Rewind

When the Magnetic Tape Unit receives this instruction, tape movement begins in a backward direction and continues until the beginning-of-tape is detected. Data are parity checked and the character count is checked on each blockette.[1]

Rewind With Interlock

When the Magnetic Tape Unit receives this instruction, tape movement begins in a backward direction and continues until the beginning of tape is detected. Further tape movement is then inhibited until the interlock is manually released on the control panel of the Magnetic Tape Unit. Data are parity checked during rewind[1] and character count is checked on each blockette.

TIMING

The following times provide the basis of computing operational times for the Magnetic Tape Unit.

---

[1] If a parity error is detected during rewind, the MTU will automatically re-read the blockette in which the error occurred. If the error still exists after three attempts to read, the MTU will stop at the end of the blockette in which the error occurred. This same process will also take place if a character count error is detected.

17

Tape transport Speed: 75"/sec.

Start Time, Write: (including acceleration and blockette spacing time)

                              0.5" Blockette Spacing: 7 ms.
                              1"   Blockette Spacing: 13 ms.

Stop and Lockout Time: 10 ms. (This includes deceleration time and the lockout or reverse direction time. The minimum time between operations involving tape movement is thus 10 ms.)

Start Read Times: (assuming previous stop lockout delay has elapsed)

OPERATION	0.5 BLOCKETTE SPACING	1" BLOCKETTE SPACING
READ FORWARD AFTER PREVIOUS READ FORWARD	7 ms.	16 ms.[1]
READ FORWARD AFTER PREVIOUS READ BACKWARD	3-5 ms.	3-5 ms.
READ BACKWARD AFTER PREVIOUS READ FORWARD	3-5 ms.	3-5 ms.
READ BACKWARD AFTER PREVIOUS READ BACKWARD	7 ms.	16 ms.[1]

Blockette Read Time: 11.5 ms. This is the time for 120 characters to pass under the read head when the tape is traveling at a speed of 75"/sec., and the characters are recorded at a density of 139 to the inch.

Blockette Write Time: 11.5 ms.

Wind and Rewind Rates: 75"/sec.

Write and Check: 1/2" Blockette Spacing: 85 ms.
                              1"   Blockette Spacing: 93.5 ms.

Tape Search: For each Tape Search operation, Tape Search occurs at a rate of 75" of tape per second plus approximately 50 ms. The 50 ms. includes all start-stop times involved and also the recording of the find on the input-output track of the high-speed drum connected to the Magnetic Tape Unit.

End Blockette Sensing: 0.65 ms. per blockette is time required for tape unit to determine that inter-blockette spacing has been entered.

Total Blockette Hand-   Sum of start time, plus read time, plus end blockette
ling Time for Read: sensing time, plus stop time.

---

[1] Additional time is required for every 6th blockette because 2.4" inter-block spacing is included in this time.

18

	START SAME DIRECTION	READ	EBS	STOP	TOTAL
1/2" BLOCKETTE SPACING	7	11.5	.65	10	29.2 MS.
1" BLOCKETTE SPACING	13	11.5	.65	10	38.5 MS.[1]

Total Blockette Hand-
ling Time for Write:
Sum of the average time to access the input-output track, plus start time, plus write time, plus end blockette sensing time, plus stop time.

	OUTPUT TRACK AVERAGE ACCESS TIME	START SAME DIRECTION	WRITE	EBS	STOP	TOTAL
1/2" BLOCKETTE SPACING	2.5	7	11.5	.65	10	31.65 MS
1" BLOCKETTE SPACING	2.5	13	11.5	.65	10	41 MS.[1]

Relating the above reading and writing times to 2400 foot reels of tape, the following table can be applied:

BLOCKETTE SPACING	1/2"	1"
BLOCKETTES PER REEL	20,000	2,350 BLOCKS
READ (139 CHARACTERS / INCH DENSITY	9.5 MIN.	9.0 MIN.
WRITE(139 CHARACTERS / INCH DENSITY	10.6 MIN.	9.6 MIN.
WRITE AND CHECK	28.7 MIN.	22.4 MIN.
TAPE SEARCH (ASSUMING 100 FINDS PER REEL)	6.2 MIN.	6.8 MIN.
REWIND	6.0 MIN.	6.6 MIN.

CHECKING

Automatic checking of the MTU includes

    1. parity check on each character processed;

    2. 120 count check on each blockette processed;

    3. parity and 120 count check during rewind.

(Note: See "Instruction Repertoire" for programmed write and check instruction.)

If an error is detected during the check operation, the processing of a current blockette is repeated. If the 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. Error recovery is discussed in the Section on "Programming Techniques."

---

[1] Additional time is required for every 6th blockette because 2.4" inter-block spacing is included in this time.

As with all UFC peripheral equipment, communication of control information between the computer and a Magnetic Tape Unit is exchanged through a Demand Station which utilizes two sets of control lines, as in the Model 0, or three sets as in the Model 1. A complete discussion of the Demand Station concept is included in the UFC Model 1 Programming Manual; hence only points having particular significance for the MTU operation will be covered here.

Computer to Input-Output Control Line (Symbolized C-to-I/O)

A total of thirteen input instructions may be sent to the MTU over C-to-I/O lines A-D. The line or combination of lines that activates any given function is internally wired and cannot be assigned by the programmer. The functions and their respective activating lines are listed in Table I. For the MTU to receive instruction signals it must be "on demand" and in a "ready" status. Only one input-output instruction at a time can be given to a UFC Magnetic Tape Unit.

Ready and Not Ready Status

Once an MTU receives an instruction, it is in a "not ready" state and can receive no other instruction until the sequence of operations initiated by the current instruction has been completed. At this time the MTU assumes the "ready" status.

On Demand

The Magnetic Tape Unit is placed on demand by a demand-in signal to the Demand Station of the tape unit. The tape unit remains on demand until the main computer program calls for another demand station. This status allows the input-output track of the demanded unit to be plugboard addressable.

High Speed Input-Output to Computer Control Lines (Symbolized (HS) I/0-to-C)

Part of the demand station circuitry of a UFC-1 MTU consists of four (HS) I/0-to-C lines over which control signals can be sent from the I/O Unit to the computer. In the MTU, these lines are available as four receiving hubs (W, X, Y, Z) on the control panel of the MTU (see Fig. 1).

The following seven terminal conditions, necessary to control the operation of a Magnetic Tape Unit, are automatically detected by the circuitry of the UFC MTU. The conditions, which when detected cause a signal to be sent to the appropriate hub on the control panel as shown in Figure 4 are:

    Search Find-Equal
    Search Find-Greater-Than or Less-Than (Greater-Than for Forward Search;
        Less-Than for Backward Search)
    End of File
    End of Data
    End of Blockette Count
    Beginning of Tape
    End of Tape

By making a jackplug connection from a terminal condition hub to (HS) I/O-to-C hub, the programmer can connect any four of the above seven control conditions to W, X, Y, or Z. Ordinarily it would be unusual to expect more than four of the seven conditions to develop on any one MTU in any one program. However, in programs where more than four control conditions must be used to alter the central computer program, the condition(s) least likely to occur can be plugged to I/O-to-C control lines a-1 (see section ff.).

When a tape unit is demanded and (1) a particular terminal condition hub has been plugged to an (HS) I/O-to-C hub, and (2) the same terminal condition has been detected in the MTU, a "special out" results which notifies the computer of the condition and provides for program variation.

For programming purposes it is necessary to understand the timing of the terminal condition signals; i.e., when they are initiated and what stops them. From this information the programmer can determine when to expect a "special out" as a result of a "demand in" and construct the program accordingly.

"End of File" (at least one word of Z's) and "End of Data" (at least one word of %'s) are code words which must be stored on the tape together with the actual data. Once the MTU detects one of these conditions, a signal is emitted at the appropriate hub and continues until the MTU buffer cycles again, i.e., until another instruction is received. In some internal programs, the execution of the instruction being sent to the MTU may be conditionally inhibited, depending on whether a Special Out exists. (See UFC-1 Programmers' Manual.) The first time the MTU is demanded after a Special Out occurs, the MTU instruction must not be inhibited, as the Special Out condition will still be present. (See "Programming Techniques," Example 1, Input Routine, Model 1.)

Although the above conditions, i.e., End of File and End of Data, are detected in rewind operations, they are cleared as the next blockette of data passes the read head and cycles through the buffer.

Search Find Equal and Search Find◇ occur when specific conditions are met in tape search operations (see section on "Tape Search"). When one of these conditions is met, a signal is emitted at the appropriate hub on the MTU control panel and is present until the MTU receives another instruction.

Beginning of Tape and End of Tape are transparent areas at the physical ends of the tape and are approximately three feet in length. These areas are photoelectrically detected. The signals are present only when the clear area is under both photoelectric cells. These conditions should occur only after wind or rewind operations or immediately after a reel of tape is mounted on the MTU; i.e., the beginning of tape signal should be present when the first instruction applying to a particular reel of tape is received by the MTU.

The end-of-blockette-count signal is initiated when the blockette count equals the selected limit (20,000 blockettes for UFC mode and 2,350 blocks for Univac I and II mode). The signal will continue to exist until the count equals 21,000 blockettes or 2,350 blocks. If the counter does reach these figures, it will be reset to zero. However, it would be unwise to attempt to exceed the limit of the counter by more than 200 or 300 blockettes, as the end of tape might occur with any excess over and above 300. There is enough good tape guaranteed after the preset limits

(1) to allow completion of the recording of any item up to 127 blockettes in length, (2) to record the required sentinels, and (3) to record a "memory damp" of approximately 100 blockettes.

If the end-of-blockette-count hub is patched to an (HS) I/0-to-C in write operations, a "special out" will result from all demands after the limit is reached until the counter is reset by a rewind operation or a master clear.

Input-Output to Computer Control Line (Symbolized I/0-to-C)

These lines are used in UFC Model 0 systems to transmit the control signals discussed above. However, as they are used to activate relay operated selectors, the program must allow for 15 or 20 milliseconds delay required to "pick up" these selectors (see example under "Programming Techniques"). The lines may also be used to transmit control signals in a Model 1 system if more than four terminal conditions are being used to alter the central computer program.

PROGRAMMING TECHNIQUES

The following routines illustrate the importance of the preceding information from a programmer's point of view. In the examples that follow, special emphasis is placed on the programming method of accomplishing the exchange of control information between the MTU and the computer.

Example 1

Input Routine - UFC-1

This example illustrates the method by which the main computer program may be set up to handle the MTU in input operations on the UFC-1. Special emphasis is placed on the utilization of the automatic terminal condition detectors of the MTU. Note that no computer time is needed to test for End of Data or End of File sentinels. The tests are made off-line in the MTU and, when an End of Data or End of File condition does occur, the demand station circuitry automatically provides for program variance through a "special out".

> ### Problem (see Program Chart and Flow Chart following)
>
> Data recorded on the input tape are to be read into the computer (MTU is on demand station 04). An end of file sentinel indicates that the main program is to be altered. An end of data sentinel indicates that there is no more valid data on the tape and that the tape should be rewound. There is a label recorded in the first blockette of the tape, and this label is to be checked.
>
> Assume that
>
> 1. the Beginning of Tape terminal condition hub is wired to I/0-to-C hub W,
>
> 2. the End of File terminal condition hub is wired to I/0-to-C hub X,
>
> 3. the End of Data terminal condition hub is wired to I/0-to-C hub Y.

PROGRAM CHART – INPUT ROUTINE – UFC-1

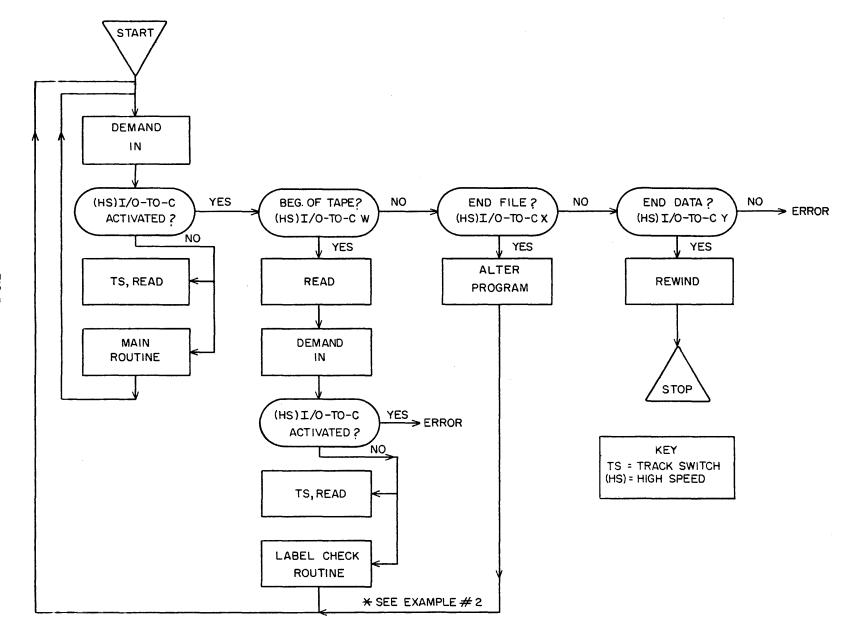| STEP #	U	V	W	OPS	COMMENTS
130	140	556	200	DE	Demand MTU, TS, and Read. If there is a special out, <u>inhibit</u> TS & Read, and go to step 200. There should be a special out with the first Demand.
131	MAIN ROUTINE				
200	04W	△△△	157	TIΔ	Test for Beginning of Tape condition. If it exists, go to label checking routine at step 157. (See Routine in example 2.)
201	04X	△△△	203	TIΔ	Test for End of File condition. If it exists, go to program altering routine at step 203.
202	04Y	△△△	225	TIΔ	Test for End of Data condition. If it exists, go to exit routine at step 225.
203	041	556	204	DEΔ	Demand MTU, do <u>not</u> inhibit execution of the instruction. Read in next blockette to determine what the program is to do next.
204	PROGRAM ALTERING ROUTINE				
224	992	992	130	UJΔ	When program is altered, re-enter main routine at step 130.
225	041	569	130	DEZ	Demand MTU, do <u>not</u> inhibit execution of the instructions, Rewind, Stop. Because Special Out will result, PAK will be set to 130 before computer stops. When reel is changed and program is to be resumed, the program will start at 130.

FIG. 5
FLOW CHART — MODEL I INPUT ROUTINE

24

Example ?

Input Routine - UFC-O

This second example illustrates the method by which the main computer program
may be set up to handle the MTU in input operations on the UFC-O (see Flow Chart
following).

When using an MTU with a Model 0, the control signals are sent from the MTU to
the computer over low speed I/O-to-C lines. Program variance is obtained by
activating selectors with the signals received over these lines. A Model 0
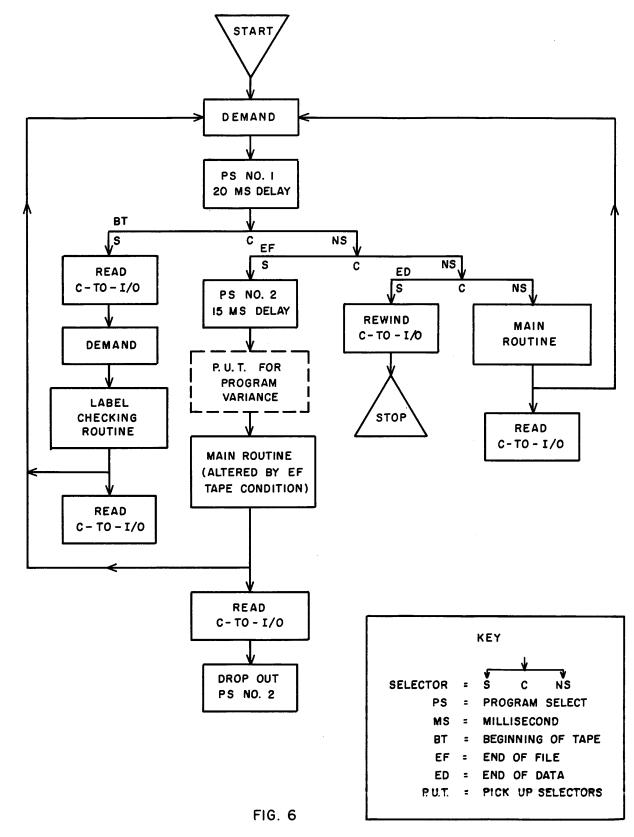solution to the same problem used in example 1 is presented in the flow chart.

Comments on Flow Chart

The first time the MTU is demanded after a reel of tape is mounted, the begin-
ning of tape signal should be present. The "demand out," however, will occur
before this signal has had time to activate a selector on the computer plugboard.
Therefore, the first demand-out (see flow chart) is run through a program sel-
ect which provides a 20 millisecond delay and thus allows the beginning of tape
selector to be picked up.

The Read command is then given to the tape unit so that the first blockette may
be read onto the input-output track. The Read command also drops out the begin-
ning of tape sentinel condition. The unit is then demanded and the demand-out
is wired to the beginning of the label checking routine. The demand-out input
hub will emit a pulse only after the input transfer from the tape unit to the
computer has been completed. Note that all subsequent demand-out pulses are
delayed through Program Select #1 so that there will be time after detection of
End of File or End of Data terminal conditions for program altering selectors or
exit routine selectors to be activated. The End of File or End of Data sentinel
must be recorded in the first word of the blockette to guarantee that the selectors
will be picked up by the time the delayed-out of the program select emits a pulse.

Tape Labels

Computer data-handling procedures require a minimum error limit which is beyond
human capabilities. For example, if an operator mounts 5000 reels correctly,
but on 5001 he mounts an incorrect reel (perhaps last week's payroll data in-
stead of this week's), then this entire section of the payroll will be incorrect,
the master file will be erroneously updated, and the chances of discovering the
error before considerable processing has been done are small. Therefore, since
one error can be extremely costly to correct, every means within reason must be
taken to prevent tape labeling errors. Magnetic tape labeling, computer updating
of labels, and computer checking of labels provide a comparatively inexpensive
method of guarding against these errors.

FIG. 6

FLOW CHART — MODEL O INPUT ROUTINE

26

Every reel should have identifying information recorded in the first item on the tape. Generally this data can be in the first word of the item in the following format:

<div align="center">DDDDDFFFRRR Δ</div>

FFF is the file code named (for example MPR might stand for Master Payroll file);

RRR is the sequence number of the reel within the file;

DDDDD is the date that this reel was created; thus the label

<div align="center">08127MPR003 Δ</div>

Would be interpreted as reel 3 of the Master Payroll File as of 8/12/57.
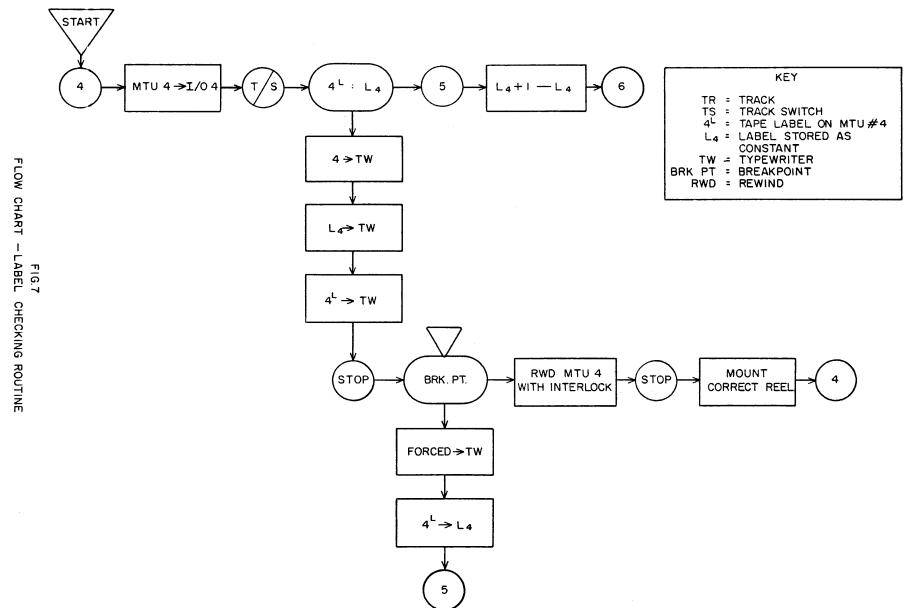
Example 3

The following Flow Chart and Program Chart illustrate a label-checking routine which might be used in an installation with MTU on demand stations 4 and an Inquiry Typewriter on demand station 0.

<div align="center">PROGRAM CHART - LABEL CHECKING ROUTINE</div>

STEP #	U	V	W	OPS	COMMENTS
110	081	27M	PRO	01	Constant - Shows correct label
111	000	000	000	010	
[1]112	FOR	CED	ΔIA	BEL	
157	041	556	158	DE Δ	Demand MTU, Read 1 blockette[2]
158	140	556	ΔΔΔ	DE Δ	DE MTU, TS Read blockette. A special out should not occur.
159	040	110	ΔΔΔ	CP 9	Compare incoming label with Const.
160	992	992	130	JZ Δ	If = jump to 130. If ≠ there is an error
161	157	ΔΔΔ	000	AT Δ	
162	101	553	ΔΔΔ	DE Δ	Type out contents of 157, which
163	110	ΔΔΔ	000	AT Δ	will show what DS involved. Also
164	101	553	ΔΔΔ	DE Δ	type out stored label and incom-
165	040	ΔΔΔ	000	AT Δ	ing label.

1 Note entry to 157 in Example 1.

2 Do not inhibit execution of this instruction if a special out exists, as the beginning-of-tape condition is still present. A special out will result and the next step executed will be the one at the W address (158).

FIG. 7
FLOW CHART — LABEL CHECKING ROUTINE

28

KEY

TR = TRACK
TS = TRACK SWITCH
4^L = TAPE LABEL ON MTU #4
L_4 = LABEL STORED AS CONSTANT
TW = TYPEWRITER
BRK PT = BREAKPOINT
RWD = REWIND

166	101	553	△△△	DE6	Set breakpoint 1. Stop. Operator decides whether to force label (Jump to step 210) or to rewind and mount correct reel (go to step 167)
167	041	562	168	DEZ	Rewind and stop. Mount correct reel and resume at next step (168)
168	992	992	157	UJ △	
210	112	△△△	000	AT △	Transfer FORCED LABEL to TW Output
211	101	553	△△△	DE △	Type Out FORCED LABEL
212	040	992	110	AT △	Put correct label in constant storage
213	110	111	110	AD △	Update label
214	992	992	130	UJ △	Jump to Main Program

Example 4

Output Routine - UFC-1

An example will show how the automatic blockette counter warns of the approaching End of Tape in a write operation and how the signal is utilized to provide the necessary program variance. In this example, note that no computer time is required until the signal is received; that is, no computer time is required either to keep count of the number of blockettes written on the tape or to test this count against the preset limit.
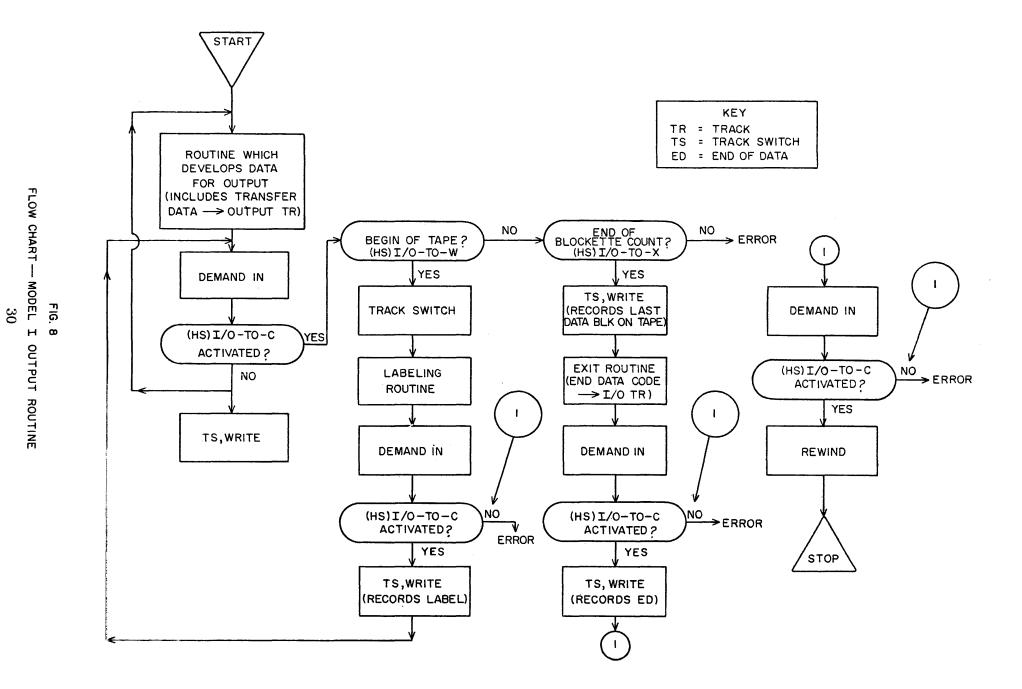
Problem

Data are to be recorded on output tape (MTU is on demand station 05) until the limit of 20,000 blockettes is reached. Then an end of data sentinel is to be recorded, and the tape is to be rewound with interlock. A new output tape is to be mounted, the correct output label recorded, and the main routine continued.

A Flow Chart and Program Chart presenting a solution to the problem are shown on the following pages.

Beginning of Tape terminal condition hub is wired to I/O-to-C hub W. End of Blockette count hub is wired to I/O-to-C hub X.

PROGRAM CHART - OUTPUT ROUTINE

STEP #	U	V	W	OPS	COMMENTS
130		MAIN PROGRAM GENERATING OUTPUT DATA				
174					
175	150	553	300	DE	Demand MTU, TS, Write. If special out results, inhibit execution of above and go to step 300.

FIG. 8
FLOW CHART — MODEL I OUTPUT ROUTINE

30

176	ΔΔΔ	992	130	UJ	Go to main routine.
300	15W		303	TI	Test for Beginning of tape condition. It should be present with first attempt to write on tape. If present go to labeling routine at step 303.
301	05X		307	TI	Test for End of Blockette count. If it exists, go to exit routine at step 307.
302					Program should not enter this step.

<table>
<tbody>
<tr><td rowspan="11">Labeling Routine</td></tr>
</tbody>
</table>

303			05Z	CC	Clear Channel. Note that last output blockette is on track connected to MTU.
304	117		053	AT	Transfer output label from internal storage to output track.
305	151	553	306	DE	Demand, TS, Write to record the label on the output tape. Do <u>not</u> inhibit execution of this instruction as Beginning of Tape signal is still present and special out will result.
306	ΔΔΔ	992	175	UJ	Label is now on tape and output data on track connected to computer. Therefore, conditions are same as when we first entered step 175.
307	151	553	308	DE	Demand, TS, Write. Do <u>not</u> inhibit this instruction. Blockette count signal will still be present, so special out will result. Records last data blockette on tape.
308	118		052	AT	Transfer End of Data sentinel to output track.
309	151	553	310	DE	Demand, TS, Write. Do <u>not</u> inhibit the instruction. Blockette count signal will still be present so special out will result. Records sentinel blockette on tape.
310	051	562	130	DEZ	Demand, Rewind with interlock. Do not inhibit this instruction. Because blockette signal will still be present, special out will result and program will jump to 130. When rewind reduced blockette counter below 20,000 the signal will stop.

Example 5

Output Routine - UFC-0

This example illustrates an output routine on the UFC Model 0. A flow chart is
shown on the following page.

Comments on Flow Chart

When the MTU is next demanded after the 20,000th blockette has been written on
the tape, the End of Blockette count signal which is wired into an I/O-to-C line
will reach the computer. However, since in all probability the MTU will be
"ready", the "demand out" pulse will occur at approximately the same time. In
order, therefore, to provide time for the End of Blockette count signal to act-
ivate a program-varying selector, the "demand out" pulse must be delayed 15 ms
by PS1.

Although the End of Blockette count selector is now activated, there is another
blockette of output data ready for recording on the tape. When this new block-
ette is recorded, the program enters the exit routine (as shown in the flow chart).

Tape Search

The circuitry of the MTU is so constructed that in a Tape Search operation the
corresponding character positions from the tape blockette and the identifier
loaded on the MTU I/O track are compared except in positions where there is an
ignore code in the identifier (see Fig. 4). Comparison is suppressed for these
positions. Thus the identifier can be from 1 to 120 characters in length and
can be split into as many sections as the programmer desires.

Example 6

The following example illustrates the coding required to initiate a Tape Search
$\geq$ for a given multiblockette item. The identifier or key is stored on track 04.
Because the Magnetic Tape Unit, in this example is on track 06, the identifying
information must be transferred from track 04 to track 06. The coding is shown
in the following diagram. The coding process also places ignore codes in the
non-identifying character positions.

STEP	U	V	W	OPS	EXPLANATION
199	–	–	–	K	CLEAR GENERAL STORAGE BUFFER TO 's
200	04V	ΔΔΔ	98V	ATΔ	PUT SEARCH VALIDATION CHARACTER IN GSB
201	04S	ΔΔΔ	98S	ATΔ	PUT 1st PORTION OF IDENTIFIER IN GSB
202	042	ΔΔΔ	982	ATΔ	PUT 2nd PORTION OF IDENTIFIER IN GSB
203	98Z	ΔΔΔ	06Z	BTΔ	BLOCK TRANSFER GSB TO MTU I/O TR.
204	161	558	400	DEΔ	DEMAND MTU, TRACK SWITCH, START TAPE SEARCH $\geq$ MTU BUFFER NOW LOOKS LIKE FIG. 11
NN1 ΔδΔ NN2 220 TDΔ (NN1 & NN2 REPRESENT MAIN PROGRAM STEP)					STEP WHICH TESTS TO SEE IF MTU "READY" I.e., IF SEARCH IS OVER

KEY

SELECTOR = S   C   NS
PS = PROGRAM SELECT
ms = MILLISECOND
BT = BEGINNING OF TAPE
BC = BLOCK COUNT
ED = END OF DATA
IMM = IMMEDIATE

START

ROUTINE WHICH
DEVELOPES
OUTPUT DATA

DEMAND IN

READY?   NO → DELAY UNTIL READY

YES

DEMAND OUT

PS 1 20ms.
DELAY

PS 1

BT

S   C   NS

BC

LABEL →
I/O TR

PS 12

S   C

S   C

NS

WRITE
(C→I/O)

DROP OUT
PS 11, PS 12
BC

PS 11

S   C

NS

OUTPUT DATA
→
I/O TR

ED →
I/O TR

OUTPUT DATA
→
I/O TR

WRITE
(C → I/O)

REWIND
(C → I/O)

PS 12
(IMM OUT)

PS 11
(IMM OUT)

STOP

WRITE
(C → I/O)

WRITE
(C → I/O)

FIG. 9

FLOW CHART — MODEL O OUTPUT ROUTINE

33

CHARACTER POSITIONS

040	I	0	0	7	4	7	I	6	9	2	D	D
041	D	D	D	D	D	D	D	D	D	D	D	D
042	Δ	Δ	Δ	Δ	Δ	Δ	S	M	I	T	H	Δ
043	D	D	D	D	D	D	D	D	D	D	D	D
044	D	D	D	D	D	D	D	D	D	D	D	D
045	D	D	D	D	D	D	D	D	D	D	D	D
046	D	D	D	D	D	D	D	D	D	D	D	D
047	D	D	D	D	D	D	D	D	D	D	D	D
048	D	D	D	D	D	D	D	D	D	D	D	D
049	D	D	D	D	D	D	D	D	D	D	D	D

TRACK 04 WORD ADDRESSES

D = DATA NOT RELEVANT TO IDENTIFIER

FIG. 10

CODING TO INITIATE TAPE SEARCH ≧
FOR MULTI-BLOCKETTE ITEM

34

i	i	i	7	4	7	I	6	9	2	i	i
i	i	i	I	I	i	i	I	I	i	i	i
Δ	Δ	Δ	Δ	Δ	Δ	S	M	I	T	H	Δ
i	i	i	i	i	i	i	i	i	i	i	I
i	i	i	i	i	i	i	i	i	i	i	i
I	i	i	i	i	i	i	i	i	i	i	i
i	i	i	i	i	i	i	i	i	i	i	i
I	i	i	i	i	i	I	I	I	i	I	I
i	i	i	i	i	i	i	i	i	i	i	i
i	i	i	i	i	i	i	i	i	i	i	i

FIG. II

IDENTIFIER IN MTU BUFFER

For a tape search involving 60-character items, the identifier is loaded in the blockette according to the following diagram.

Error Recovery

Although the circuitry of the system provides for automatic error recovery in most cases, it is possible to have an error from which the only means of recovery is to redo or rerun the transaction on which the error occurred. This means returning to a point at which previous conditions can be re-established. In tape processing, this means returning all the way to the beginning of the entire run unless special provisions are made. In large multireel problems, steps are usually taken to avoid reprocessing the entire problem if trouble develops. Two possible methods are:

Batch Processing

The data may be broken down into logical groupings and each group processed as an entity. For example, in an inventory problem involving stock numbers ranging from 100,000 - 999,999, a logical breakdown might be 100,000's, 200,000's, 300,000's, etc. Thus, if trouble developed when processing 801741, the rerun would have to go back only to 800,000 instead of all the way to 100,000.

Memory Dump

At certain logical points, such as the end of every output reel, the contents of the computer memory are recorded on the output tape. If, therefore, it becomes necessary to reconstruct a certain portion of the output, the information is available so that processing can start at the beginning of the reel in which the desired output will occur.

Assignment of Control Functions to the High-Speed Control Lines

When assigning control functions to high-speed control lines, consideration must be given to the way these lines will be tested in the computer; by internal or external methods. If the method of testing is to be internal, then the most common control function should be assigned to the control line that will be tested first; that is, the control function record in frequency of occurrence should be assigned to the high-speed control line that will be tested second and so on through the four control functions which may be assigned to HSCL's on any one MTU. If the testing is to be external, every attempt should be made to avoid the use of selectors because of the consequent delay. The following diagram shows a possible wiring of the testing section on the plugboard in order to test for the four conditions which are represented by the control lines.

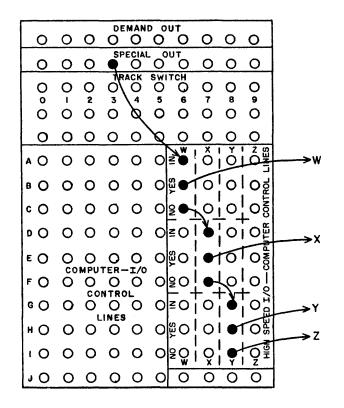If we assume that the MTU is on Demand Station 4, and

```
    Search, Find Equal is                         W
    Search, Find Greater Than or Less Than is     X
    End of File is                                Y
    End of Data is                                Z
```
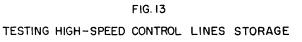
then the plugboard would be wired as shown in the diagram.

CHARACTER POSITIONS

WORD	11	10	9	8	7	6	5	4	3	2	1	S	
0	i	i	i	7	4	7	i	6	9	2	i	i	⎫
1	i	i	i	i	i	i	i	i	i	i	i	i	
2	i	i	i	i	i	i	S	M	i	T	H	i	⎬ 1st ITEM
3	i	i	i	i	i	i	i	i	i	i	i	i	
4	i	i	i	i	i	i	i	i	i	i	i	i	⎭
5	i	i	i	7	4	7	i	6	9	2	i	i	⎫
6	i	i	i	i	i	i	i	i	i	i	i	i	
7	i	i	i	i	i	i	S	M	i	T	H	i	⎬ 2nd ITEM
8	i	i	i	i	i	i	i	i	i	i	i	i	
9	i	i	i	i	i	i	i	i	i	i	i	i	⎭

FIG. 12
IDENTIFIER FOR TAPE SEARCH ON 60
CHARACTER ITEMS

FIG. 13

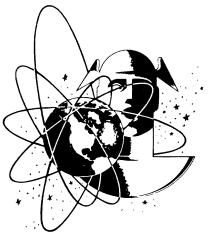TESTING HIGH-SPEED CONTROL LINES STORAGE

38

****

The information contained in this manual is designed to serve as a comprehensive guide for the programmer who will operate the UNIVAC FILE-COMPUTER MAGNETIC TAPE UNIT. However, if a programmer is not thoroughly versed in computer operation, he may find that he needs further explanation of specific points. The Management Services and Operations Research Department of Remington Rand invites inquiries from any source. Write to Remington Rand, 315 Fourth Avenue, New York 10, New York.

UNIVAC® **- The FIRST Name in Electronic Computing Systems**