G-15 TECHNICAL BULLETIN EQUIPMENT SERIES

ACCESSORY MTA-2

MAGNETIC TAPE UNIT

FOR THE BENDIX G-15

COMPUTER

MAGNETIC TAPE UNIT MTA-2

REVISION NOTICE

This manual, AEG 05571-2, is a major revision of T 7-1.

Revisions

Inclusions

CONTENTS

TABLES

MAGNETIC TAPE UNIT MTA-2

Magnetic tape units provide inexpensive, convenient and compact auxiliary storage. One to four MTA-2 units may be connected to the computer; facilities are included for the unique addressing of each tape unit. Each interchangeable tape reel can hold 300,000 words.

Information may be written on tape or read from tape under computer control at a rate of 430 characters per second. (A character consists of four binary digits. The four binary digits may represent a decimal digit, if desired.) Tape may be searched in both the forward and reverse directions, under computer control, at a rate of 2500 characters per second.

Some uses for magnetic tape are:

To hold routines which may be read into the computer and executed under program control.

To hold large amounts of data which may be processed by the computer.

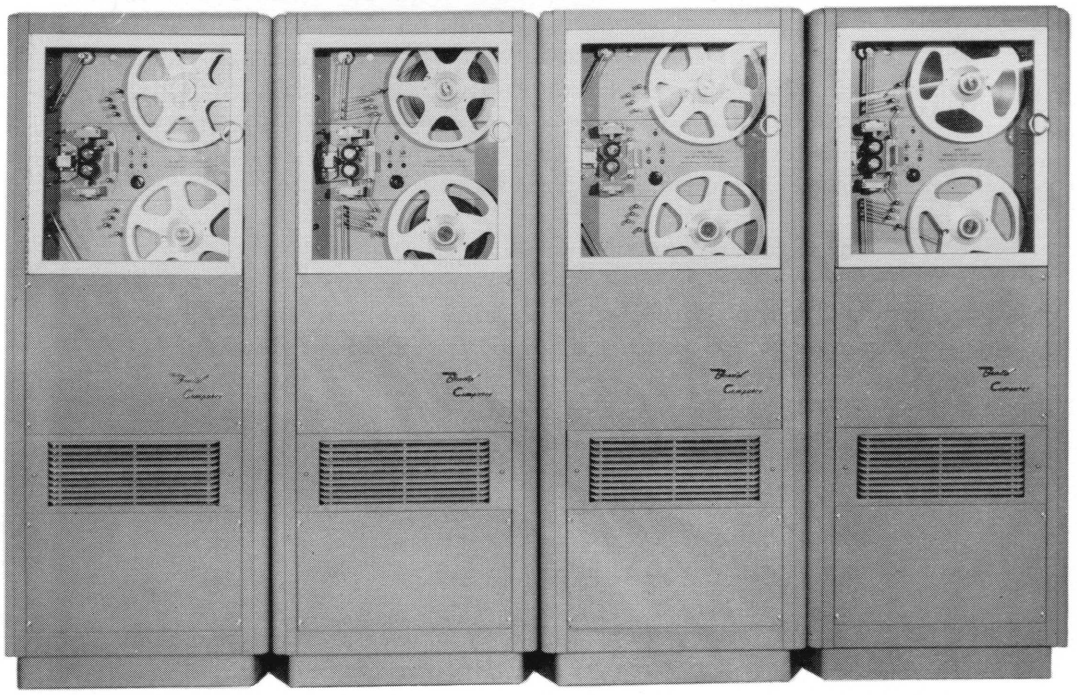
To hold intermediate results of computation which will be called back onto the memory drum when required by the program.

To hold the final results of computation which will be typed out later by the computer.

Information is written or read in blocks of up to 108 words. The information on tape can be divided into file sections to facilitate search. A file section may consist of any arbitrary number of blocks; it is identified by a "filecode," a bit in the sixth level on the tape, written under program control.

The Magnetic Tape Service Routine

The basic machine commands which control the magnetic tape units, together with the timing and other



FOUR MTA-2 MAGNETIC TAPE UNITS

conditions for their use, are described in this manual. A magnetic tape utility routine is available, however, in which timing considerations are handled automatically. The magnetic tape utility routine is convenient when tape is used to hold a library of programs or to hold information temporarily during the check-out of new programs.

When the routine is in use, the operator can instruct the computer to perform the magnetic tape operations listed below from the typewriter keyboard. Any one of four tape units may be specified. BLK is a file number from 001 to 999.

KEYBOARD OPERATIONS FOR MAGNETIC TAPE SERVICE ROUTINE

Record memory channels and/or paper tape blocks in first empty file on magnetic tape.

Transfer file BLK from tape into memory channel.

Write file number BLK on tape.

Locate file number BLK on tape.

Compare contents of file BLK with contents of memory channel.

Punch file BLK from magnetic tape onto paper tape.

Record memory channels and/or paper tape blocks in file BLK on magnetic tape.

The magnetic tape utility routine is described in a separate publication.

Magnetic Tape Commands for Intercom 1000

Intercom 1000 is an easy-to-use, interpretive system for programming the G-15 Computer. The system includes magnetic tape commands in which the timing conditions listed in this manual are handled automatically.

The magnetic tape commands for Intercom 1000 are listed in the accompanying table. Any one of four tape units may be specified. The file numbers may range from 0000 to 3000.

Write on Magnetic Tape
Read Magnetic Tape
Write File Number on Magnetic Tape
Reverse Magnetic Tape one Block
Search Magnetic Tape for File Number

The magnetic tape commands for Intercom 1000 are fully described in the Intercom 1000 Manual.

BASIC PROGRAMMING FOR MAGNETIC TAPE

The Reading and Writing Process

During a command to write on magnetic tape, information is automatically read from Line 19, four words at a time, to the tape unit. Information is read from word-positions 107, 106, 105, and 104. After a group of four words is read from Line 19, the remaining contents of the line are shifted ahead four word-positions so that new information is in word-position 104

to 107. The read-out and shifting process continues until Line 19 is empty. When Line 19 is completely empty of information, the process automatically stops and a STOP code is written on the tape.

During a command to read magnetic tape, information is automatically read from the tape, four words at a time, into words 00, 01, 02 and 03 of Line 19. As each group of four words is read into Line 19, all earlier information read into the line is moved ahead four word-positions. Information continues to be read from tape into Short Line 23 and then into Long Line 19 until a STOP code occurs on the tape. If all 108 words of Line 19 have been recorded on tape, the information read back into the computer will be in the same word-positions as prior to recording.

Short Line 23 in the memory is used by both the reading and writing process. Consequently, the line can not be used to hold information during execution of a command to read or write on magnetic tape. Note that read-out onto tape starts from the "high" end of Line 19, proceeds in four-word segments, and ceases when Line 19 is empty of information. Read-in is into the "low" end of Line 19. Therefore, if it is desired that information recorded on tape be read back into its original word-positions, at least one "one" bit must exist in either word 00, 01, 02, or 03 in Line 19 prior to recording; a 108-word block will then be recorded on the tape.

Recording on a section of tape does not automatically erase earlier-recorded matter on that section of tape; new information cannot be written on top of old information. Information is erased from reels of tape by use of a separate bulk eraser.

After the execution of the command "Write on Magnetic Tape," a delay of four drum revolutions should follow the setting of the READY state before calling for any input operation.

A description of each magnetic tape command follows. Except when expressly stated otherwise, the timing restrictions listed refer to successive tape operations in the same magnetic tape unit.

Write on Magnetic Tape	w 00 N C 01 31

The contents of Line 19 are written on magnetic tape at the rate of 430 four-bit characters per second. Words 107, 106, 105, and 104 are the first to be transcribed and are followed by groups of four words until Line 19 is empty. When Line 19 is empty, a STOP code is written on tape and the computer is automatically put in the READY state.

If this command follows a "Search Magnetic Tape" command for any tape unit, at least 16 drum cycles must elapse after the READY state is reached before the "Write" command is given.

If this command follows an earlier "Write on Magnetic Tape" command at least one drum cycle must elapse after the READY state is reached before the "Write" command is given.

Read Magnetic Tape	L_2 N C 13 31

Tape is run in the forward direction and is read into Line 19 until a STOP code appears on the tape. File codes on the tape have no effect.

If this command follows a "Search Magnetic Tape" command for any tape unit, at least 16 drum cycles must elapse after the computer reaches the READY state before the "Read" command is given.

If this command follows a "Write on Magnetic Tape" command, at least 4 drum cycles must elapse after the READY state is reached before the "Read" command is given.

If this command follows a "Write File Code" command, at least 4 drum cycles must elapse after the execution of the file code command before the "Read" command is given.

Write File Code on Magnetic Tape L_5 N C 30 31

A file code is written on the tape in a separate channel reserved for this purpose. The tape does not move and nothing in memory is affected.

This command should be preceded by a series of commands which move the tape slightly to provide leader ahead of the file code. The command sequence to be used will depend upon the amount of leader required.

If a single file code is to be written between blocks the "WRITE-SET READY" sequence should be used. It will provide approximately one-half inch of leader.

If successive file codes are to be written with no data blocks between them the "READ-SET READY" sequence must be used. It will provide approximately one inch of leader. If file codes are closer together than one inch, subsequent search operations involving those codes will be marginal.

"Write-Set Ready" or "Normal Leader" Sequence (½ inch)

EXAMPLE:

L	T	N	C	S	D	Executed at
L	W00	70	C	01	31	Write (word 00 of drum cycle n)
70	W69	68	0	00	31	Set Ready (word 69 of drum cycle n+1)
68	73	N	C	30	31	Write file code (words 69-72 of drum cycle n+2)

Tape start signal is at word 00 of drum cycle n.

Tape stop signal is at word 00 of drum cycle n+2.

The above is only an example. The same results can be obtained provided the following rules are followed:

1. The SET READY command can be executed any time within drum cycle n or n+1; no matter where it is executed within this period, the READY signal will operate at word 00 of drum cycle n+2 and will cause the tape to stop.

2. The WRITE FILE CODE command must not be executed prior to word 50 of drum cycle n+2, otherwise the tape might still be in motion at the time of execution, with the result that the file code will be improperly written and a subsequent search for it will be marginal.

It is convenient to execute the SET READY command late during drum cycle n+1 to sufficiently delay the WRITE FILE CODE command without requiring any additional commands for delay purposes.

"Read-Set Ready" or "Successive File Code Leader" Sequence

EXAMPLE:

L	T	N	C	S	D	Executed at
17	15	14	C	13	31	Read (word 18 of drum cycle n through word 14 of drum cycle n+1)
14	W14	11	0	00	31	Set Ready (word 14 of drum cycle n+3)
11	10	60	0	00	00	Delay (word 10 of drum n+5)
60	65	N	C	30	31	Write File Code (words 61-64 of drum cycle n+5)

Tape start signal is at word 18 of drum cycle n.

Tape stop signal is at word 00 of drum cycle n+5.

The READY signal, which stops the tape, is set at word time 00 of the second drum cycle following the execution of the SET READY command, hence in the above example the tape drive is energized for 4 drum cycles and 91 word times, or approximately 140 miliseconds. This will provide approximately 1.05 inches of leader.

The following rules apply to writing routines to provide at least one inch of leader.

1. If execution of the READ command is started prior to word 30 of drum cycle n, SET READY can be executed any time during drum cycle n+3, and the WRITE FILE CODE command can be executed as early as word 50 of drum cycle n+5 (but no earlier!) ... or

2. If execution of the READ command is started after word 30 of drum cycle n, SET READY can be executed any time during drum cycle n+4, and the WRITE FILE CODE command can be executed as early as word 50 of drum cycle n+6 (but no earlier!).

3. Additional leader can be obtained by delaying the SET READY command additional drum cycles relative to the READ command. Leader will be increased by approximately .22 inches for each additional drum cycle. The WRITE FILE CODE command must never be executed prior to word 50 of the second drum cycle following that in which SET READY is executed in this sequence.

In both sequences above, Line 19 will be precessed by 4 words.

The WRITE FILE CODE command does not use the input-output hardware of the G-15.

After the execution of the WRITE FILE CODE command at least four drum cycles must elapse before calling for any other input or output operation.

Search Magnetic Tape Forward L_1 N C 05 31

The magnetic tape is run at high speed in the forward direction until a file code appears. The tape stops in front of the block following the file code. The information from the tape is not entered into the memory.

If this command follows a "Write on Magnetic Tape" command, at least 4 drum cycles must elapse after the READY state is reached before the "Search" command is given.

If this command follows a "Write File Code" command, at least 4 drum cycles must elapse after execution of the file code command before the "Search" command is given.

If this command follows a "Search Magnetic Tape" command, at least one drum cycle must elapse after the computer reaches the READY state.

Search Magnetic Tape Reverse L_1 N C 04 31

This command is identical to "Search Magnetic Tape Forward" except that the tape is run in the reverse direction.

If the file code was written using the series of commands given under "Write File Code" the tape will stop in the blank area between blocks of information.

If the file code was written without leader, the tape will stop within the data block preceding the file code. This procedure is not recommended.

Reverse Read for Stop Code

This is a sequence of commands which will cause the tape to move in a reverse direction until a valid stop code is encountered. The tape will overshoot the stop code by a minimum of 1/4 inch.

If it is known that the tape is positioned in leader, the following sequence should be used:

L	L_2	L_2	C	04	31	Rev. Search
L_2	L_4	N^2	0	12	31	Gate Type In

If it is known that the tape is positioned in data, or if the tape position is unknown, the following sequence must be used:

L	L_1	L_1	C	04	31	Rev. Search
L_1	L_3	N^1	0	12	31	Gate Type In

If the tape is positioned at the trailing edge of a data block, this sequence will miss the stop code it is adjacent to and read the next valid stop code. If it is in leader, it may or may not pick up the first stop code. If any case, it will always stop at a valid stop code.

One drum cycle delay is required after READY prior to the execution of the next magnetic tape command in both cases above.

Special Forward Read for Stop Code

A "Reverse Read for Stop Code" leaves the tape positioned in data. The following sequence must be used to move the tape forward before giving the regular "Read" command:

L	L_{70}	L_{70}	C	05	31	Fwd Search
L_{70}	L_{72}	N^{70}	0	12	31	Gate Type In

The tape stops in leader following the first valid stop code. This sequence may be used whenever the tape is positioned in data or the tape position is unknown. Any "Search" command may be given when the tape is positioned in data.

SUMMARY OF BASIC MACHINE COMMANDS AND WAITING TIMES

Commands

Write on Tape		w00	N	C	01	31
Read Tape		L_2	N	C	13	31
Write File Code on Tape (1/2" leader)		w00	70	C	01	31
	70	w69	68	0	00	31
	68	73	N	C	30	31
Search Tape Forward . .		L_1	N	C	05	31
Search Tape Reverse. . .		L_1	N	C	04	31
Reverse Read for Stop Code (Tape Positioned in Leader)	L	L_2	L_2	C	04	31
	L_2	L_4	N	0	12	31
(Tape Positioned in Data or unknown position) .	L	L_1	L_1	C	04	31
	L_1	L_3	N	0	12	31
Special Forward Read for Stop Code . . .	L	L_{70}	L_{70}	C	05	31
	L_{70}	L_{72}	N	0	12	31

TABLE OF WAITING TIMES

COMMAND TO BE GIVEN	MINIMUM WAIT TIME IN DRUM CYCLES WHEN FOLLOWING:						
	READ Fwd/Rev	WRITE	WRITE FILE CODE	SEARCH (Fwd. or Rev.)	TYPE IN	ANY OTHER INPUT	ANY OTHER OUTPUT
READ (Fwd. or Rev.)	0 / 1 After READY	4 After READY	4	16* After READY	3 After READY	0 After READY	1 After READY
WRITE	0 / - After READY	1 After READY	0	16* After READY	3 After READY	0 After READY	1 After READY
WRITE FILE CODE	50WT / - After READY	50 WT After READY	--	--	0	0 After READY	0
SEARCH (Fwd. or Rev.)	0 / 1 After READY	4 After READY	4	1 After READY	3 After READY	0 After READY	1 After READY
SET READY	--	0**	--	1	--	--	--
ANY OTHER INPUT	0 / 1 After READY	4 After READY	4	1 After READY	3 After READY	--	--

* This delay must follow a search operation on ANY tape unit in the system.

** When using the WRITE-SET READY sequence for leader, give the SET READY command at any time within two drum cycles after the WRITE command. Wait at least two and one-half drum cycles after the WRITE command before writing the file code.

TAPE POSITIONS POSSIBLE

The figure on the next page pictorially represents the various conditions normally encountered on magnetic tape. These are:

(1) leader between blocks without file codes.
(2) leader preceding a file code.
(3) file code without preceding leader (not recommended). *
(4) adjacent file codes.

The methods of reaching each location are also tabulated:

Points B, D, J, N are at the edge of the preceding data block and are reached via the Write, Read, and Special Forward Read commands only.

Points A, C, and I are in data and were reached by the Reverse Read sequence.

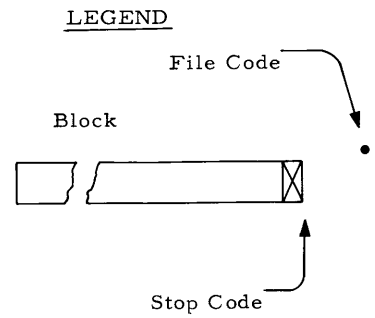
Point H is in data and was reached by the Reverse Search when no leader preceeds the file code. *This case should not be allowed to occur.

Points E and K are in leader and were reached by the Reverse Search when leader preceded the file code.

Points G, P and M are in leader and were reached by the Forward Search.

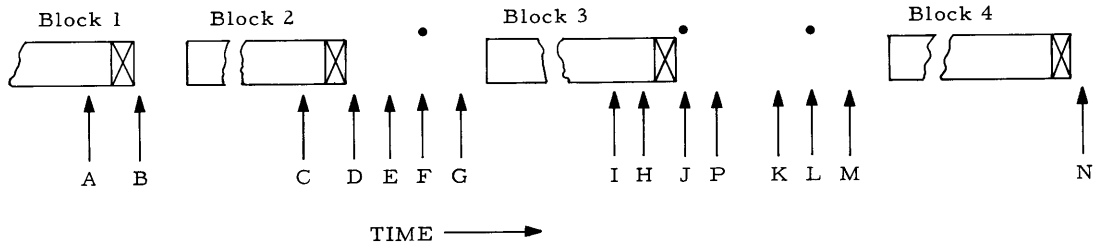
This covers all of the normal cases.

POINTS	REACHED BY
B, D, J, N	Write, Read
A, C, I	Reverse Read for Stop Code #
E, H*, K	Reverse Search for File Code
G, P, M	Forward Search for File Code
F	Write File Code with Normal Leader
L	Write File Code with Long Leader
J*	Write File Code without Leader



Overshoots by minimum of .225 inches

* This use of file code is to be avoided, and is shown only for comparison.



PICTORIAL REPRESENTATION OF TAPE CONDITIONS AND POSITIONS

MOVE FROM	TAPE TO	COMMAND STRUCTURE						OPERATION
B F L	D J N	L	w 00	N	C	01	31	Write on Magnetic Tape - The contents of Line 19 is written on tape.
B D, E, F, G J, K, L, M, P	D J N	L	L_2	N	C	13	31	Read Magnetic Tape - Data is read from tape into Line 19.
-	-	L	L_5	N	C	30	31	Write File Code - A file code is written in channel 6. The tape does not move.
A, B F, G J, P	G P* M	L	L_1	N	C	05	31	Search Forward - The tape is moved forward at high speed to next file code.
H*, I, J N K, L	E K H*	L	L_1	N	C	04	31	Search Reverse - The tape is moved in reverse at high speed to next file code.
B D, E, F, G J, P, K, L, M	A C I	L L_2	L_2 L_4^2	L_2 N^2	C 0	04 12	31 31	Reverse Read (Case 1) - Reads in reverse to stop code. Must start in blank tape.
C, D E, F, G, H, I, J P, K, L, M, N	A C I	L L_1	L_1 L_3^1	L_1 N^1	C 0	04 12	31 31	Reverse Read (Case 2) - Reads in reverse to stop code. Permits starting in data.
A C H*, I	B D J	L L_{70}	L_{70} L_{72}	L_{70} N^{70}	C C	04 13	31 31	Special Forward Read - To follow Reverse Read Permits starting in data.

* This use of File Code is to be avoided.

TABLE OF G-15 COMMANDS FOR MTA-2

Remember . . .

A BLOCK is the name given the contents of channel 19 when it is written on tape. A block may consist of from 4 to 108 words. If a block consists of less than 108 words, the information will be displaced from its original position in Line 19 when it is read back into the computer.

When the utility routine is in use, the first block of each file contains a file number placed there by the routine. These file numbers, one number in each file, number the files on tape in sequential order.

A STOP code is automatically written on the tape after every block of information. The STOP code causes the tape to stop moving after a "Magnetic Tape Read" command. The command to read magnetic tape, therefore, causes only one block of information to be read.

A FILE CODE is written on the tape, when the command "Write File Code" is given. The file codes are for the convenience of the programmer in searching for specific sections of tape. When the tape is being searched for a file code, the tape moves six times as fast as when it is being read.

File codes are not numbered in basic machine coding. File numbers, ranging from 0001 to 3000 are assigned to the first block following the file code in the Intercom 1000 Programming System.

Cases arise when unusual uses are made of FILE CODES. Volumes would be required to explain every possible case. The following facts should be born in mind when using the FILE CODE system:

1) The tape unit must be stopped when a FILE CODE is written.

2) The FILE CODE detection circuit is insensitive during the time the FILE CODE SEARCH command is in the EXECUTE state. Hence, the T number may be used as a means of discrimination as follows:

$T = L_1$ ignores file codes for the first drum cycle.
$T = L_2$ detects file codes as soon as tape is in motion.

3) A FILE CODE SEARCH operation (FORWARD or REVERSE) will involve tape speeds that vary between 7-1/2 and 45 inches per second, hence the amount of tape passing the head in a given period of time during search operations will vary with durations of the searches and the durations of the intervals between searches. In round numbers, the tape can accelerate from 7-1/2 to 45 inches per second in 2 seconds will decelerate from 45 to 7-1/2 inches per second in 1/2 second. For example, six drum cycles worth of leader produced by a READ-SET READY sequence would pass the head in one drum cycle when searching at 45 inches per second. This suggests that one inch of tape between consecutive file codes is not enough to assure one drum cycle of time elapsing between the reading of a search command and the time at which the FILE CODE is detected. A "T" number of L_2 would be required in such a case if the capstan speed were to approach 45 inches per second during the search.

The Set Ready Command Does Not Always Immediately Set Ready

In all IN/OUT cases other than MAG SEARCH REVERSE (04) and GATE TYPE IN (12), READY will not necessarily be set until word 00 of the second drum cycle following execution of SET READY command. Therefore in determining how soon an IN/OUT command can be executed after a SET READY command, the above-mentioned delay must be taken into account.

EXAMPLE: How specific blocks of information on tape can be located and read into the computer.

A programmer has written 50 blocks of information, 108 words in each block, on magnetic tape. He has written a file code every 10 blocks. He now wants to read the second and third blocks, after the fourth file code, into the computer. Assuming the tape is in the rewound position, a sequence of operations to do this might be (each operation to be followed by a ready test and appropriate delay):

1. Search Magnetic Tape Forward (4 times).
   Each time the command is given, the machine will stop on a file code. After the command is given the fourth time, the tape will be resting at the fourth file code.

2. Read Magnetic Tape (2 times).
   The first time this command is given, the first block after the fourth file code will be read into Line 19. A STOP code prevents more than one block of information from being read in. The second time the command is given, the second block on the tape after the file code will replace the first block in Line 19.

3. Transfer the contents of Line 19 to some other memory line.

4. Read Magnetic Tape (1 time).
   Since the tape will have stopped between the second and third blocks after the file code, this command will now cause the third block to be read into Line 19.

Other methods could be used to locate a block of tape. For example: Give successive "Magnetic Tape Read" commands and compute a check sum of the contents of each block of tape as it is read into the computer. When the computed check sum coincides with a specific, earlier-stored sum on the memory drum, the

block corresponding to that earlier-stored sum is in Line 19. Or, instead of taking a check sum, look for a coincidence between the last word of each block of tape and an earlier-stored word on the drum.

OPERATING INSTRUCTIONS

Each MTA-2 has a "Tape Unit" switch with positions numbered 1 to 4. The switch setting is used to identify the tape unit addressed in commands. When a command controlling the magnetic tape units is given, the number in the "C" position of the command determines which tape unit will be affected. Switch numbers 1, 2, 3 and 4 correspond to "C" numbers 1, 2, 3 and 0, respectively. For example, a command with "1" in the "C" position will control the unit, or units, that has its "Tape Unit" switch set at 1. Thus, information may be recorded simultaneously on more than one tape. However, only one tape at a time may be read during input.

The recording of information on a section of tape does not automatically erase old information on that section of tape. Therefore, tape reels should be demagnetized before recording.

The power switch of the magnetic tape unit should be turned on or off only when the computer is turned on and the control panel neons are in the READY configuration.

The operating procedure is:

1. Put the "on-off" and "run-standby" toggle switches, located on the face of the tape transport unit, in the "off" and "standby" positions, respectively.

2. Put the rotary selector switch in the "S" position.

3. Turn on computer power.

4. When the computer neons are in the READY configuration, turn on the "on-off" switch on the magnetic tape unit.

5. After about one minute, place the "run-standby" toggle switch in the "run" position.

6. Put the rotary selector switch in the "A" position.

The magnetic tape unit is now under program control. If the tape unit is not needed for a considerable length of time, the "on-off" and "run-standby" toggle switches should be placed again in the "off" and "standby" positions.

The procedure for turning off the tape unit is:

1. When the computer control panel neons are in the READY configuration, put the rotary selector switch in the "S" position.

2. Put the "run-standby" switch in the "standby" position.

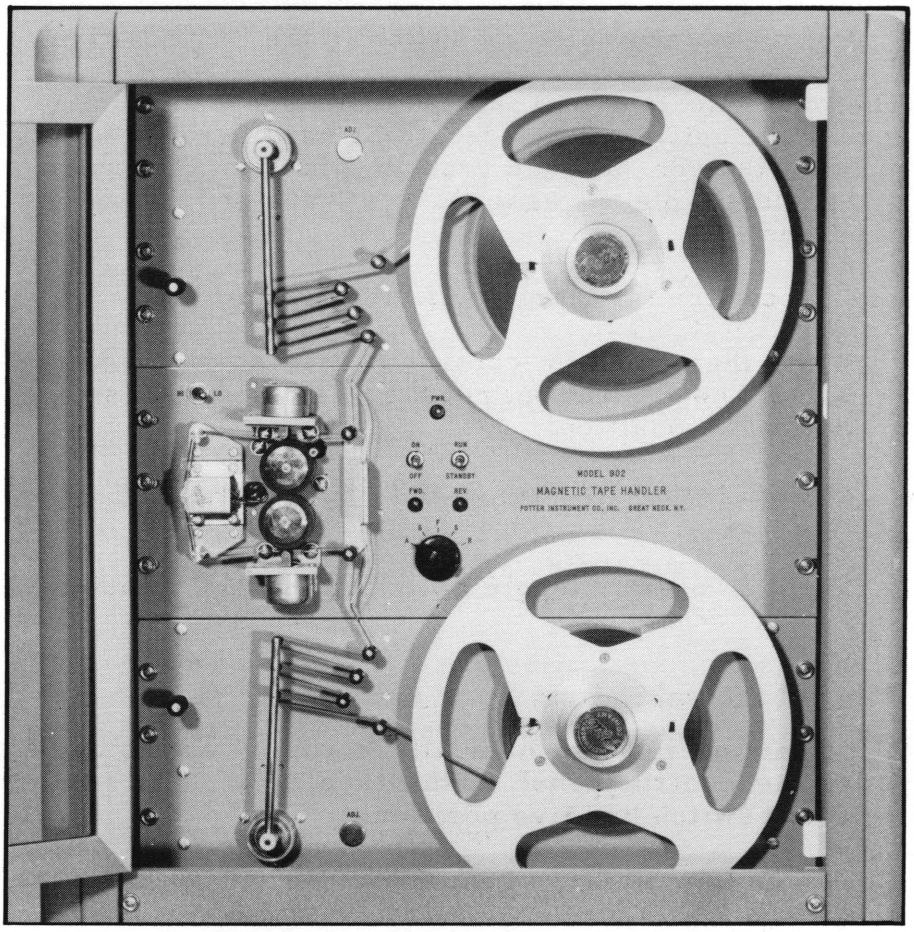
3. Put the "on-off" toggle switch in the "off" position.

Manual Control of Tape

Tape motion may be manually initiated and stopped from the control panel of the tape unit. The rotary selector switch has five positions:

A	Automatic
S	Stop
F	Forward motion
S	Stop
R	Reverse motion

The "Hi-Lo" toggle switch permits selection of one of two speeds for manual tape wind or rewind, either 7-1/2 or 45 inches per second.



The Magnetic Tape Handler, showing the manner in which tape is threaded

INITIAL INSTALLATION

Connect the Accessory MTA-2 main cable to the receptacle in back of the computer labeled "Magnetic Tape." (A second tape unit to be used with the same computer is connected by plugging its cable into a receptacle in the first tape unit; similarly, a third tape unit is connected to the second and a fourth is connected to the third.)

Connect each Accessory MTA-2 power cable to a 115-volt, 60-cycle outlet of at least 6-ampere capacity. (Do not use the 115-volt receptacles in the back of the computer.)

SPECIFICATIONS

The magnetic tape contains six channels. Information is written or read from tape four bits at a time. The four bits are held in four parallel channels on the tape. The fifth tape channel holds a bit which specifies whether or not the first four channels hold numerical information or control bits. Control bits and the fifth channel bits are recorded automatically when required and need not be programmed. The sixth channel holds file codes.

Forward search and reverse search speed is 45 inches per second. Reading and writing speed is 7-1/2 inches per second. Recording density is 57 characters per inch.

A 108-word block is written in approximately 2 seconds, using 15 inches of tape.

Return-to-zero recording is used; magnetic saturation occurs in one direction.

Tape is one-half inch wide and 3600 feet long on a reel of 10-1/2 inches maximum diameter (N. A. B. hub). The magnetic tape used is Industrial Tape 159A made by Minnesota Mining and Manufacturing Company.

Maximum storage capacity is 300, 000 words per reel, at 29 bits per word.

Power requirements are 115 volts, 60 cycles. Power consumption is .64 kva.

The complete unit is the size of a standard filing cabinet (60 by 24 by 22 inches) and weighs 175 lbs.

Bendix Computer Division

AEG - 05571 - 2
REVISION of T7-1

June 1962