

A U T O N E T I C S

A DIVISION OF NORTH AMERICAN AVIATION, INC.

DATA SYSTEMS DIVISION

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RECOMP II TECHNICAL BULLETIN NO. 20

TITLE: MAGNETIC TAPE PROGRAMMING GUIDE

PURPOSE: To provide the RECOMP II programmer with the information he needs to program and operate the D4G-AB Magnetic Tape Unit.

GENERAL

The RECOMP II system with magnetic tape functions in the same manner as a standard RECOMP II, but with greatly augmented storage capability - up to 680,000 words per unit or a total of over  $2\frac{1}{2}$  million words with the permissible maximum of four units.

The read-write speed is 1850 characters per second at a tape speed of 9.25 inches per second. This allows an entire memory to be written upon or read from tape in less than 20 seconds. The move-rewind speed is 55.5 inches per second.

Information appears on tape in blocks of from 1 to 8 RECOMP II channels (64 to 512 words) in either RECOMP II format (5 bits plus a parity (odd) bit across the tape) or IBM format (6 bits plus a parity (odd) bit across the tape).

The IBM format is the odd parity or binary format. When a tape is being written, the sign and the most significant 35 bits of a word comprise the 36 bits (6 X 6) which will be written for each word. When an IBM format tape is being read, the 36 bits will occupy the least significant 36 bits of the RECOMP word. The sign and the 3 most significant bits will be random (note that, in general, a small program will be required to shift the information left 4 places and append the correct sign after an IBM format read command).

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CAUTION

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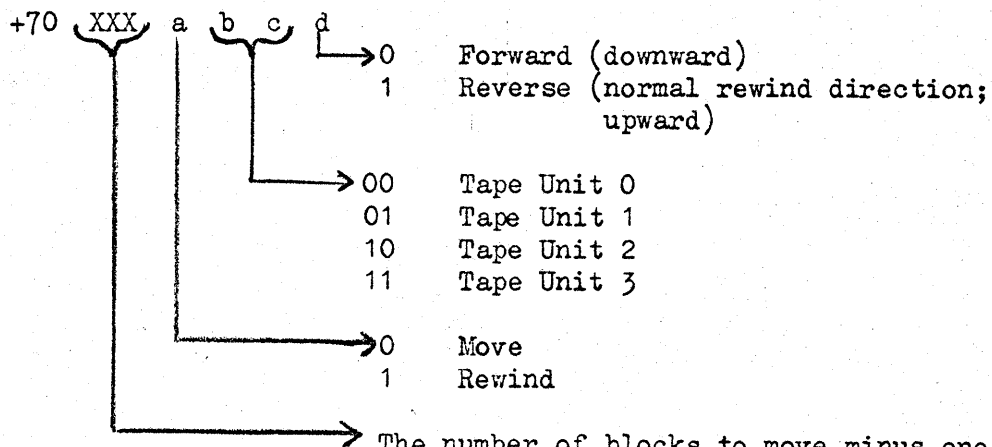
Tape reading and writing  
destroy the A register and  
the L and V high-speed loops.  
Do not attempt to read into  
or write from channel 77.

PROGRAMMING

There are 3 operation codes which refer to magnetic tape. Basically they are:

1. MOVE AND REWIND +70
2. READ +61
3. WRITE +63

The MOVE and REWIND command is used to rewind the tape in either direction or to move the tape a given number of blocks in either direction. It is used as follows (upper case letters refer to octal digits; lower case letters refer to bits in the descriptions of the address portions of all three commands):

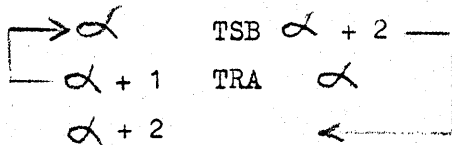


For example, to rewind tape 3 prior to use, use the command:

+70 XXX7.1 where XXX can be anything.

The computer will compute during rewind, but if an attempt is made to use a rewinding tape, the computer will HALT (2 rewinds in the same direction are permissible without causing a HALT as are 2 rewinds in opposite directions (the 2nd rewind is ignored)).

To tell whether any (one or more) tape units are rewinding, Sense Switch B on the console must be ON. Then the command TSB +54 will not transfer if there are tape(s) rewinding. Thus, a typical program which uses magnetic tape(s) will always start by rewinding all tapes to be used, doing all computing which does not use tapes (initialization, data input, etc.), and then interrogating Sense Switch B to insure that all pertinent tapes are rewound as follows:



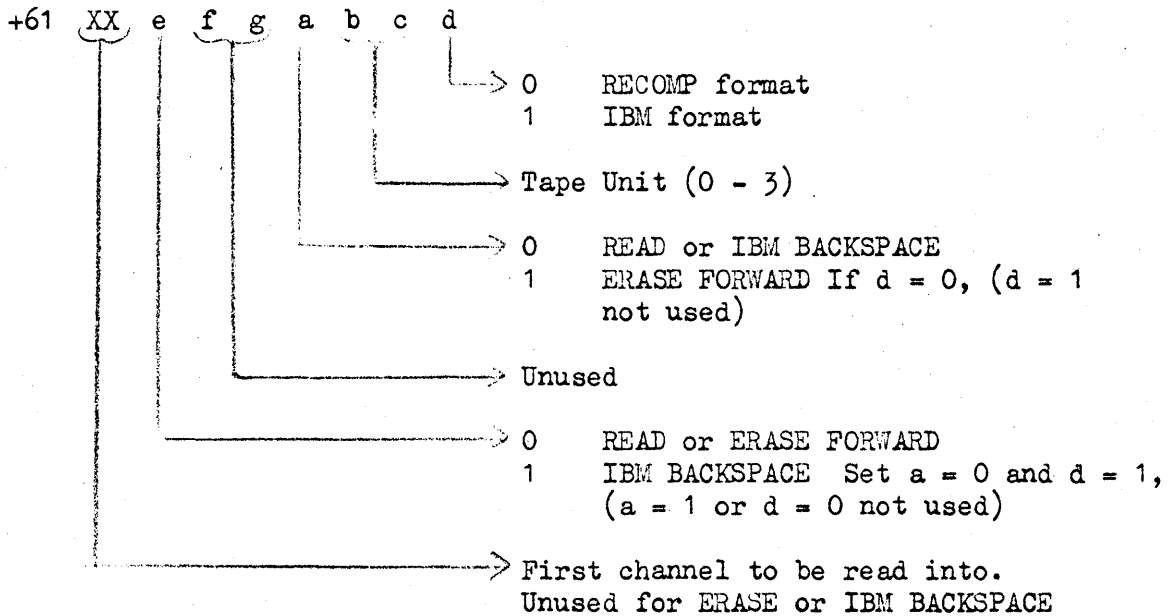
(a "tight loop" until all tapes are ready.)

The following error indications are given:

- a. If there are not as many blocks of information to move as there are specified in a Move command, the tape will move to one end or the other and then turn on the overflow indicator.
- b. The MOVE command will not work with an IBM format tape. Rewind is acceptable though.

A block number check should be made following a MOVE command, to insure that the correct number of blocks have been moved.

The READ command is used to read one block of tape in RECOMP or IBM format, to ERASE all the tape forward from a given point to the end of the tape, or to BACKSPACE one IBM format block. It is used as follows (READING and WRITING are always in the forward direction):



For example, to read an IBM block into channel 55 (and succeeding channels, if needed) from tape unit 2, use the following command:

+61 5502.1

Note that although some of the bits may vary, that a READ command consists of the first channel, a zero, the tape unit, and the format (half-word bit).

RECOMP II TECHNICAL BULLETIN NO. 20

To ERASE forward tape unit 3, use the following command:

+61 0007.0

Note that this command has all zeros, except the last octal digit, which is the tape unit number plus 4.

To IBM BACKSPACE tape unit 3, use the following command:

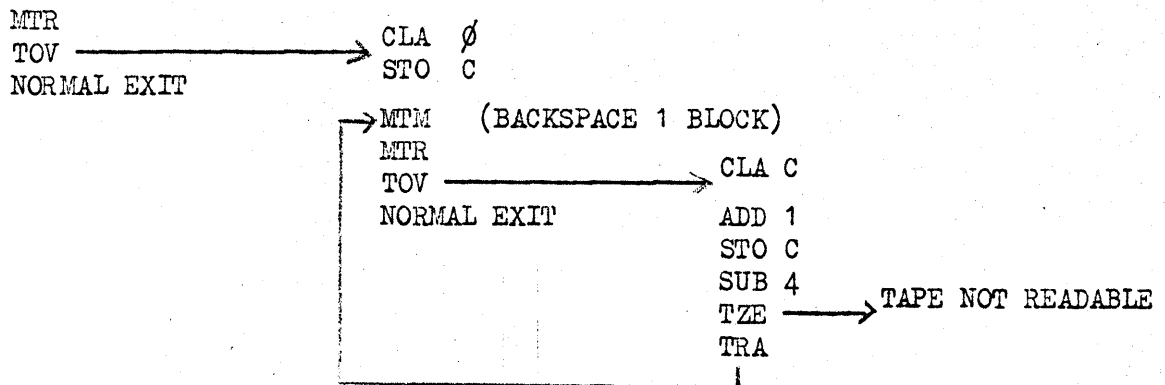
+61 0043.1

Note that this command is always +61 004X.1 where X is the tape unit.

To read a RECOMP block from tape unit 0 starting with channel 10, use the following command +61 10000.

The computer will overflow after a READ command if there is a parity error or if the tape is at its end (if there is no information to be read, the tape will move to the end and then the computer will overflow). In case of a parity error, MOVE back one block and READ again. In extreme cases, a block will read correctly even after 4 failures, so that the error provision for a read parity error should re-read 4 times before giving up.

A loop to repeat a READ up to 4 times would be as follows:



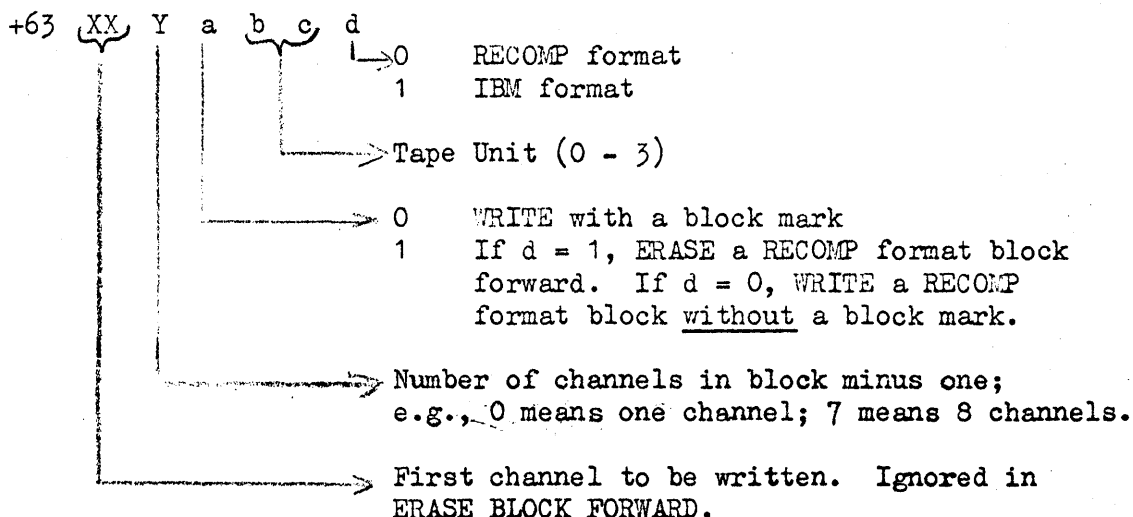
The computer will overflow if the ERASE fails, or was started in the middle of information (if tape not rewound after being loaded, for example). Failure to erase indicates a faulty tape. (The computer also overflows upon completion of a successful ERASE. However, since this command takes 10 minutes to execute and 10 minutes for the subsequent rewind, tapes will generally not be erased under computer control, but will be erased by using the switch in the front of the cabinet.

The computer will overflow after IBM BACKSPACE if the tape is at the load point; i.e., if there is no block to back up to.

It is possible to get a double error which will not be detected by a parity error overflow. It is also possible to lose a track across the tape completely. If this occurs, the last 8 words of information will never get from the V loop into memory, so that a check of any of the last 8 words to be filled will detect this error.

The most convenient method of checking for a dropped line of recording is to record a fixed pattern in one of the last 8 words of each block. This pattern can then be checked after a READ command, and, if found incorrect appropriate action taken.

The WRITE command is used to write a variable length (1 to 8 channels) block of tape in RECOMP or IBM format, or to ERASE one variable length RECOMP format block in the forward direction. It is used as follows:



For example, to WRITE a 3-channel block from channels 55, 56 and 57 in RECOMP format on tape unit 3, use the following command:

+63 5523.0

To ERASE this block (after moving back one block), use the following command:

+63 0027.1 or (if easier) +63 5527.1

To WRITE this block again without a block mark, use:

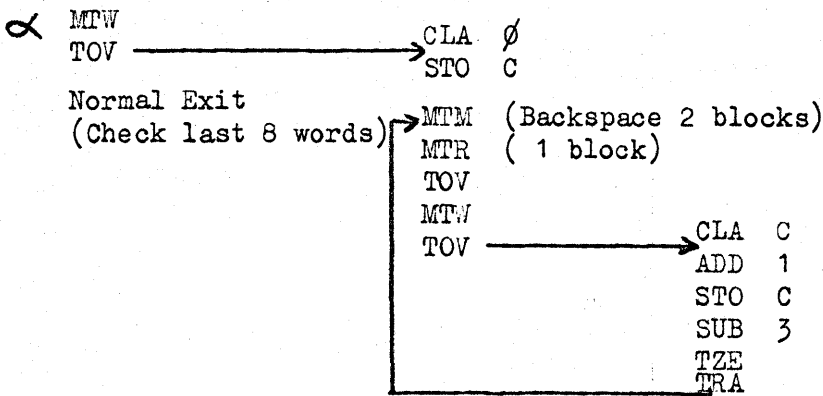
+63 5527.0

There is a parity check of the WRITE command and an overflow if a parity error is detected. To rewrite this block requires moving the tape back one block and rewriting without a block mark. If, after 3 writes, there is still an error, this block may be erased and writing attempted on the next section of tape. If an overflow occurs while erasing, the tape is bad (there is also an overflow if there is no tape left to write on (end of tape marker)).

When using the MOVE command, prior to writing without a block mark, the following precautions must be observed:

- a. A MOVE forward command must move the tape one less block than required. This remaining block must then be moved by a READ command otherwise, the desired block may be only partially read due to incorrect tape positioning.
- b. A MOVE reverse command must move the tape one block greater than required. This excess block must then be moved by a READ command.
- c. A block number check should be made following a MOVE command to insure that the correct number of blocks have been moved.

A loop to write on tape would be similar to the following:



In general, writing will be done on a pre-erased tape. In any case, no block of different length can be written over an existing block, nor can a block with a block marker be written over an existing block.

Since an IBM block is only  $\frac{3}{4}$  of the length of a corresponding RECOMP block (6 bits per word long as opposed to 8 bits per word), the ERASE BLOCK FORWARD command will erase more than an IBM block. However, if the tape is completely erased ahead of the current block, this will do no harm, and will still permit writing an IBM format tape even though the tape be bad in places. (In WRITE IBM block, no block mark is recorded).

The ERASE BLOCK command cannot be used repeatedly (over 5 times or so) without giving a move or read command followed by a move back command to correctly position the tapes relative to the block marks.

To rewrite an incorrect IBM block, backspace and rewrite. To write over a complete IBM tape requires positioning which can be done as follows:

- a. Read a block
- b. Backspace a block
- c. Write a block

RECOMP II TECHNICAL BULLETIN NO. 20

There is a switch next to the upper reel which is actuated by a special ring which fits into the reel. Without this ring in the reel, a tape cannot be written upon. This feature protects tapes from being accidentally destroyed.

If an IBM write command is given when writing is impossible, the tape moves but is not written upon.

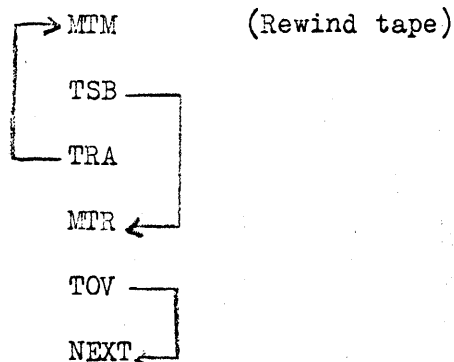
If a RECOMP write command is given when writing is impossible, the tape moves to the next block (if any).

In neither case is any indication given.

In summary, moving, rewinding, reading, erasing the whole tape, and backspacing an IBM block are straightforward, assuming the programmer knows the format and size of the blocks of information. He must obviously keep track of where the tape is or else number the blocks in some way, probably in the first word of each block. Also, a program which writes on tape usually will require an erased tape unless the programmer knows that the block sizes are what he intends to use. If tape changing or erasure must be minimized, it is recommended that all blocks be of the same length if possible, but it is entirely up to each using organization to establish its own standard operating procedure.

Pushing the Error Reset Button halts tape movement immediately (causing block orientation to be lost) except for REWIND.

As a general precaution, the first block recorded on a tape should be a dummy block. Reading of this block should be followed with a TOV command to the next command location:



OPERATING INSTRUCTIONS

Turning the Tape Unit Off

To turn the tape unit OFF, proceed as follows:

- a. Push the STOP button.
- b. Push the REV. button until the load point marker (a small silver strip) is above the read-write head a couple of inches (if the tape has been rewound under computer control, the tape need be moved only a few inches).
- c. Push the STOP button (if the tape is to be rewound, wait until the tape has wound off the lower reel to facilitate removal).
- d. Move the two (2) circuit breakers to the OFF position. This procedure insures that the tape will not be affected by transients when the unit is turned OFF.

Turning the Tape Unit On

To turn the tape unit ON, proceed as follows:

- a. Push the STOP button.
- b. Move the two (2) circuit breakers to the ON position.
- c. Push the ON button.
- d. Push the FWD. button until the load point marker is below the read-write head.
- e. Push the STOP button.

This procedure insures that the tape will not be affected by transients when the unit is turned on.

The tape unit is now in manual mode. To put it in automatic (computer) mode do the following:

- a. Push the STOP button.
- b. Push the AUTO. button.



Note that it is impossible to manually rewind the tape such that it is correctly positioned at the load point.

Therefore, all programs referring to a tape must start with a REWIND command assuming that the recommended ON-OFF procedure has been followed.

Using the Manual Controls

The manual controls (see Figure 3) are used as follows:

- a. The buttons labeled 9.25 and 55.5 select the tape speed, in inches per second, at which the tape will move when in manual mode. They do not affect automatic (computer) mode. If neither button is depressed, the speed will be 9.25 ips.
  - b. The light labeled LOAD POINT will be on when the tape is positioned with its beginning point at the read-write head (all the usable tape on the upper reel).
  - c. The light labeled END OF TAPE will be on when the tape is positioned with its end point at the read-write head (all the usable tape on the lower reel).
  - d. The button labeled ON turns the tape unit on.
  - e. The button labeled STOP, stops the motion of the tape.
  - f. The button labeled REV. causes the tape to move in the reverse (upward) direction until the tape is completely off. The lower reel or the STOP button is depressed. This is the usual direction of a rewind.
  - g. The button labeled FWD. causes the tape to move in the forward (downward) direction until the end of tape is sensed or the STOP button is depressed.
  - h. The button labeled AUTO. causes the tape to be in automatic (computer) mode.
- The buttons are interlocked such that STOP must be depressed before any other button will be operable.
- i. The rotary switch labeled 0, 1, 2, 3 selects the identifying number of the tape unit. This is the number referred to by bits b and c in the address of a magnetic tape command. See 2.
  - j. Directly inside the lower part of the tape unit is a rotary switch labeled OFF, R, W&R. When this switch is in the OFF position, the tape cannot be read from or written upon. When it is in the R position, the tape is usable, but cannot be written upon. When it is in the W&R position, the tape is fully usable. This switch can be used to protect a tape from being accidentally written upon by putting it in the R (read only) position.

- k. In the back of the cabinet is a switch labeled OFF, ERASE. In manual mode this switch can be used to erase an entire tape.

Tape Loading

To load a tape proceed as follows (See Figures):

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CAUTION

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Always load and  
remove tapes with  
the tape unit OFF.

- a. Open the transparent door no more than 90°.
- b. Mount an empty reel in the tape-up position (bottom reel) by sliding it onto the hub and then tightening the knob, which causes the hub to expand and grip the reel.
- c. Mount a full reel of tape in the payout position so that the free end of the tape hangs down from the right side of the reel. Hold the reel by its center to avoid pinching the tape.
- d. Unwind about 6 feet of tape from the reel.
- e. Wind one turn of tape around the take-up reel in a clockwise direction.

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CAUTION

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Do not slip free end of  
tape into slot in reel  
core and do not secure  
the free end to the reel  
in any manner.

- f. Hold free end of tape to core of take-up reel with finger.
- g. Wind about five (5) turns of tape on take-up reel by rotating it manually, being sure to maintain some tension on the tape so that it will wind tightly.

- h. Pull back read-write head cover.
- i. Rotate tape load handle 180° clockwise.

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CAUTION

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Maintain a firm grip on the tape load handle as it is spring loaded and will snap into position quite forcibly.

- j. Thread tape (See Figure 1).
- k. Take up slack by rotating the payout reel.
- l. Release tape load handle by rotating 180° counterclockwise, observing above caution.
- m. Push read-write head cover back.
- n. Inspect to see that the tape is properly positioned within all guide rollers and the guide trough.
- o. Close the door.

The tape is now positioned outside the load point marker. This is to prevent writing on good tape due to transients when the unit is turned on.

When the tape is turned on, it will move to normal operating position (Figure 2).

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WARNING

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Never touch the reels, tension arms or tape when they are in motion.

TAPE HANDLING AND STORAGE

Signal Dropouts

A common problem in computer recording is the dropout, generally defined as a 50% signal reduction, and most frequently caused by poor head-to-tape contact. This poor contact may be due to improper handling of the tape or to unclean heads on the recorder which lead, in turn, to contamination of the oxide surface of the tape. It may also be caused by distortion of the base material of the tape, or by a combination of all the factors mentioned here (if the dropouts are inconsistent, check the line voltage).

In computer recording, a 6 db or 50% drop in signal is considered critical. With a 5 mil wave length (the result of 200 bits per inch in the non-return-to-zero method of digital recording) this takes place at a tape-to-head separation of approximately  $\frac{1}{2}$  mil (.0005 inches). Since a dust particle might approach this size, this illustrates the importance of a clean operation.

Handling

When tape is handled, the operator's hands should be thoroughly clean to prevent contamination of the tape by body oils and salts, which will pick up foreign particles. Some operators, in addition, find it helpful to wear clean white gloves to prevent contamination when handling tape.

The head, guides, and all other surfaces contacted by the tape should be cleaned daily (and every time a tape is replaced) with Vithene D, a commercial solvent available from Tect Inc., Northvale, New Jersey.

Cleaning

If you have difficulty with signal dropouts arising from dust, carefully wipe the surface and backing of the tape with a lint-free cloth, such as a very soft chamois, before and after using. To get rid of contamination which does not brush off easily, use a cloth lightly moistened with Freon TF (available in quart, gallon and 5 gallon quantities from John B. Moore Corp., Peerless Bldg., P. O., Box 3, Nutley, New Jersey). Aliphatic hydrocarbon type solvents (heptane, gasoline, naphtha, etc.) can also be used; care should be exercised, however, since they are flammable. Freon TF is non-toxic and non-flammable. Do not use carbon tetrachloride, ethyl alcohol, trichlorethylene or other unknown cleaning agents because they may soften the oxide, deform the backing, or both.

Tape should be thoroughly cleansed of any contamination that accumulates on it from using magnetic materials in solution to make visible the recorded tracks.

Storing

Tapes, when not in use, should be placed on a precision reel for uniform winding at moderate tension and then given protected storage. The best method of protected storage is to place the reel of tape in a self-sealing plastic case and store it on end in a storage bin equipped with partitions between each reel. The plastic case protects tape from dust and sharp humidity and temperature changes. It also guards both tape and reel against handling damage when being transported between storage and work areas. Rewinding the tape once or twice a year during storage is recommended to release expansion-contraction stresses and to lessen the probability of blocking. This is particularly true of acetate base tapes.

Extremes of temperature and humidity should be avoided. In general, the recommended storage conditions for acetate and polyester base tapes are:

Temperature            60 - 80° F.

Humidity                40 - 60% R.H.

If extremes of temperature are encountered during storage or transit, tape should be brought to equilibrium before it is used. Assuming, for instance, that a tape has been in storage or transit at sub-zero temperatures, it should be stored a minimum of 4 to 8 hours at room temperature before it is used.

Actually it will not regain complete equilibrium for 16 hours. This time can be shortened by accelerating temperatures, but these temperatures should not be over 100° F.; otherwise condensation, which may or may not prove to be a problem, will form on the tape. Avoid using direct heat, such as lamps or other spot heat, to warm up a tape.

Distortion

While the majority of dropouts in recording are caused by specks of dust and other contaminants lifting the tape away from the head, the next most significant causes are dents and creases in the base material.

Dents can be caused either by foreign particles becoming wound up tightly in the roll or by roughness in the surface of the hub on which the tape is wound. These may cause a permanent set in many layers of tape which cannot be stretched out flat as the tape passes over the head. Stresses in the roll sufficient to stretch the backing 5% will generally leave a permanent impression. Stresses below the 5% point are not normally permanent.

Creases are usually caused by handling the tape (i.e., threading, removing the tape from the guides, etc.) or by damage to the edges of the tape because of uneven winding.

Most causes of distortion of the base material can be eliminated by the use of precision reels. The tapered flanges are closely spaced to minimize scattering of turns during winding and the flange design affords greatly increased protection against dust and crushing of the tape edges. The hub has no threading slots, which cause distortion of the inner turns; it is covered instead by a neoprene friction ring to aid in threading. This ring also acts as a cushion for the innermost tape layers and minimizes distortion from winding pressure and expansion-contraction stresses.

#### Accidental Erasure or Saturation

The magnetic properties of computer tapes are stable indefinitely. Magnetic reactivity is permanent unless altered by magnetic means. It may be altered, for example, by magnetic fields from permanent magnets or electro-magnets. These will very likely cause erasure if placed within a few inches of the tape.

This is the principle utilized in the bulk erasing process, in which a whole reel of tape is demagnetized without unwinding. The fields necessary to produce complete erasure, however, are so intense that it is not likely that this would occur accidentally, as in the case of proximity to current required for conventional electronic computer circuitry.

Complete erasure does not usually take place unless the field is strong enough to exert a noticeable attraction for the tape, or to induce vibration in the tape. Slight erasure can occur, however, without any noticeable attraction or vibration, at a field intensity of only 100 oersteds, and a 50% reduction of signal strength at a field intensity of 155 oersteds.

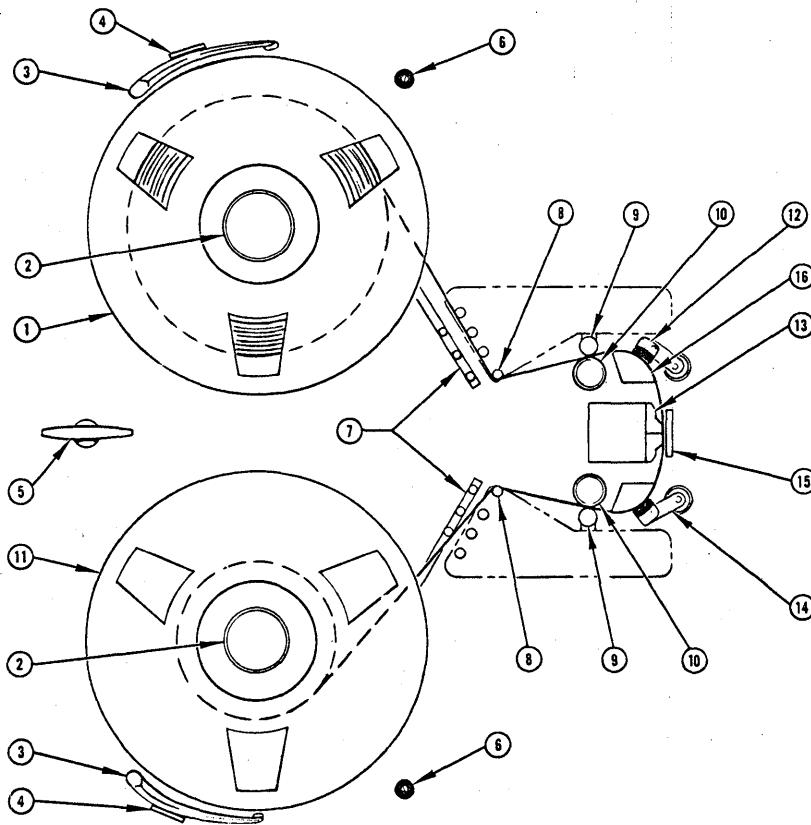
Both recorded and unrecorded tapes should be kept away from electro-magnetic bulk erasers and storage cabinets with magnetic latches. Unrecorded tapes should not be placed near D.C. magnetic fields because they may become saturated and suffer signal degradation.

It is possible that the recording head become magnetized. If this should occur, it must be demagnetized.

#### Accidental Erasure During Shipment

To guard against accidental erasure of recorded tape during shipping, tape can be packed with bulk spacing (such as wood) between it and its shipping carton. Bulk spacing is effective in reducing the possibility of accidental erasure by fields encountered during transit because field strength varies inversely with the square of the distance. Assuming no field greater than 1000 oersteds would be encountered during shipment (this is an unverifiable but reasonable assumption), 3 inches of bulk spacing would give adequate protection.

REFERENCE:            Operation & Maintenance for M906II Tape Transport System  
WRITTEN BY:           Gregory Howell  
REVISED BY:          W. G. Masoner



1. REEL - UPPER
2. REEL HUB KNOB
3. SENSING ARM - END OF REEL
4. STOP - END OF REEL
5. LOADING HANDLE
6. STOP - TENSION ARM
7. TENSION ARM
8. ROLLERS STATIONARY
9. PINCH ROLLER
10. CAPSTAN ROLLER
11. REEL - LOWER
12. DRAG BLOCK
13. READ-WRITE HEAD
14. PRESSURE PAD YOKE
15. HEAD PLATE

FIG. 1

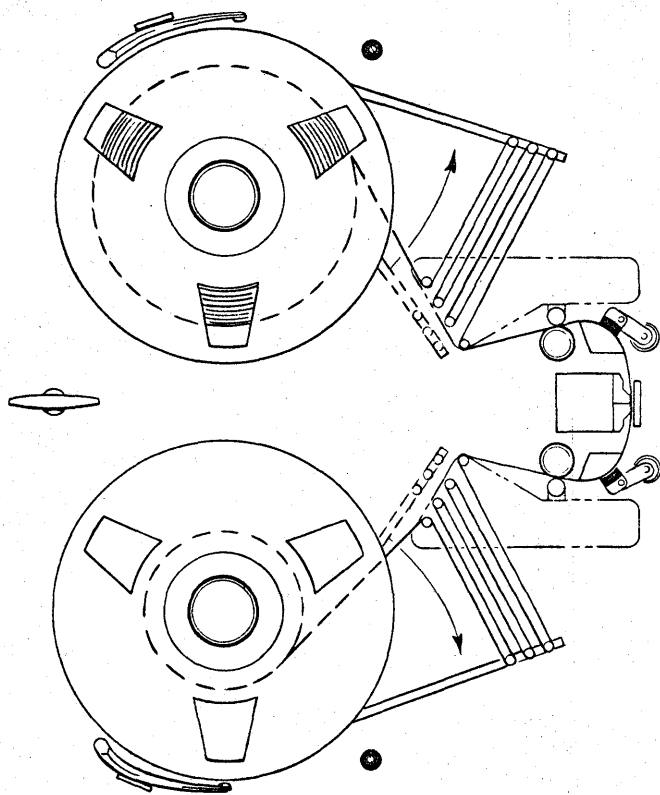


FIG. 2

CP-266-2-20



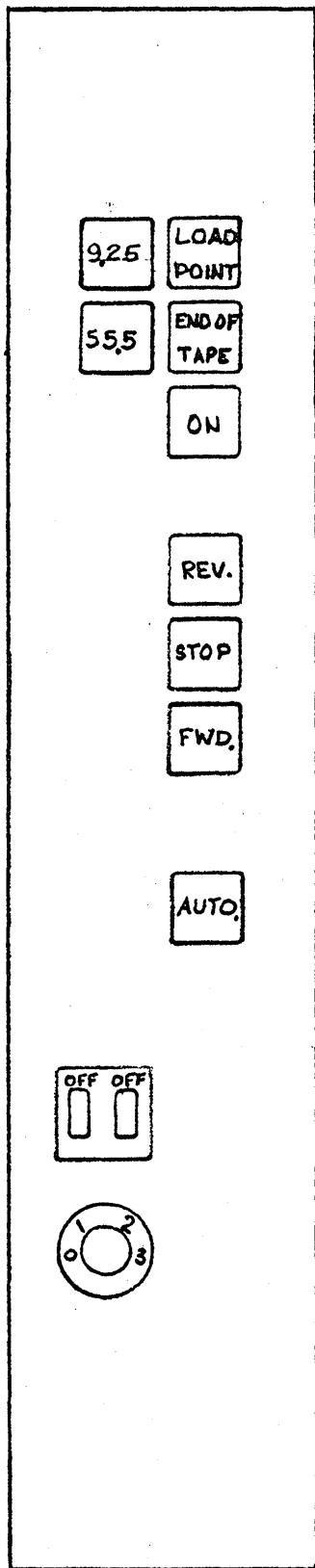


Figure 3

OPERATION CODE	e' a' d'	e' a' d	e' a d'	e a' d	a d
+ 61 *	Read RECOMP Format	Read IBM Format	Erase Forward	Backspace IBM Block	
+63 *	Write RECOMP Format	Write IBM Format	Write Without A Block Mark		Erase One Block
+70 *	Move Forward	Move Reverse	Rewind Forward		Rewind Reverse

\*NOTE: The e setting refers to the +61 command only.

COMMAND VARIABLE BIT SETTINGS

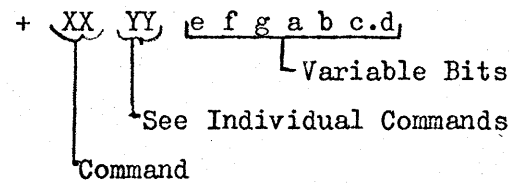


Figure 4

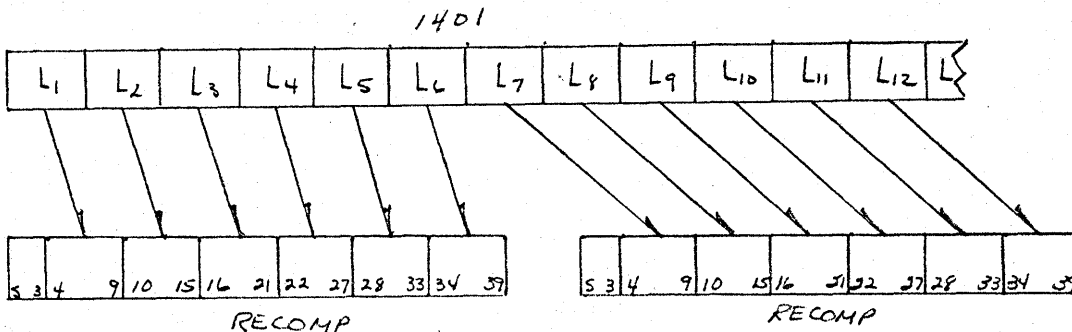


RECOMP II TECHNICAL BULLETIN NO. 20

1401 TO RECOMP (Read tape, IBM format)

The Recomp computer will accept tapes recorded by the 1401 computer, providing they have been written in "Low Density" (200 char/inch), using the "Column Binary"\* feature.

Any number of characters may be read, with the restriction that they be in multiples of 48 characters. (8 Recomp words). The resulting Recomp word will be composed of 6 1401 characters, these will be in the low 36 bits as shown below.



As noted above, any multiple of 48 characters may be read by the Recomp, using the "Read IBM Format" portion of the read tape command.

If less than 48 characters are read, the last remaining characters ( $\frac{C}{48} + R$ ) will be in either the L or V loop.

\* Refer to IBM Pub. A24-3071-1 for the 1401 column binary instructions.