IBM
TRADE MARK

727 magnetic tape unit and tester

electronic data-processing machines

customer engineering
manual of instruction

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NOTICE

THE text and illustrations in this manual have been prepared for teaching purposes and as an aid for learning the 727 Tape Drive and the Tape Drive Tester. All material was prepared from information relative to production at a given level. Engineering changes may alter logic and machine functions. Of course, these engineering changes could cause the machine's production to be at a different level from that described by this manual. Therefore, the use of this manual as a reference is subject to changes in the machine.

One change should be made in the Type 727 Magnetic Tape Unit Systems book accompanying this write-up for the systems and write-up to be at the same level, logically. This change should be made on systems page 75.10.01 as follows:

1. Remove 12 AU and the 1k-ohm potentiometer and 500-ohm resistor tied to the 12 AUn/o point.
2. Add a jumper from 12 AUn/c to terminal 3.

Doing this removes 12 AUn/o and shortens 12 AUn/c. Machines in the field should already have been changed.

ABBREVIATIONS

The following abbreviations are used throughout this manual.

caps.	capstans
EOT	end of tape
EMF	electro motive force
go-fb	go/forward-backward
LP	latch pick
L.P.	load point
LT	latch trip
LRCC	longitudinal redundancy check character
usec	microsecond
ms	millisecond
mtr.	motor
mv	millivolt
MV	multivibrator
NRZI	non return to zero
pt.	point
PU	pick up
R/W	read-write
sel	select
SS	single shot
TDT	tape drive tester
TI	tape indicator
TU	tape unit
tgr.	trigger

727 MAGNETIC TAPE UNIT, AND TESTER

MODELS I AND II

1.0 INTRODUCTION

The Type 727 magnetic tape unit is designed to provide storage and reading of large amounts of sequential information on a magnetic tape. It is controlled largely from an external source with certain automatic functions contained within the unit. Power for electronic circuits and drive motors is obtained externally while power for relay circuitry is self-contained. The unit is normally connected to EDPM equipment as an input/output device.

A reel of magnetic tape is an economical storage medium because it can be used repetitively and can contain about 1,600,000 characters in records of variable length.

The functions of the tape drive are:

- Writing
- Reading
- Backspacing
- Erasing

The mechanism provides for:

- Easy loading and unloading
- Fast rewind of tape
- Recognizing the physical ends of the tape, as well as tape breaks.

The tape drive may be operated by automatic or manual control.

2.0 MACHINE SPECIFICATIONS

2.1 TAPE DRIVE

The specifications of the tape drive are as follows:

1. Weight: 911 lbs.
2. Dimensions: 29-1/4" deep x 69" high x 28-1/2" wide.
3. Voltage: 208 three phase.
4. Vacuum: 8" water.
5. Power requirements: 1148 watts average (about 1400 watts during high-speed rewind).

2.2 TAPE

The physical medium upon which binary information is stored is a layer of magnetic oxide material coated on one surface of a plastic tape. The tape is nominally 1/2 inches wide and is arbitrary in length up to 2400 feet wound on a reel 10-1/2 inches in diameter.

The specifications on the physical size of tape are as follows:

1. The width is .498" ± .002" at 50% relative humidity and 70°F temperature.
2. The total thickness is .0022" (+.0003", -.0004").
3. The cellulose acetate base is nominally .0015" thick; the magnetic layer, .0006" thick.

The magnetic oxide tape used in EDPM equipment is of the highest quality manufactured. The control and care in the manufacturing of the tape is carefully supervised by the manufacturer. Each reel is tested twice by IBM before it is shipped to the customer.

The aim of this intense effort is to eliminate any conditions leading to an error in the recording of information or in the reading of information when using the IBM magnetic tape equipment.

2.3 HUMIDITY CONSIDERATIONS

The tape is cellulose acetate. This plastic material is dimensionally unstable insofar as relative humidity is concerned. In the range of 20% to 80% relative humidity, the lateral dimension can change as much as .0067 inches; operation beyond this range introduces even greater changes. This change in lateral dimension presents a problem of storing and using the tape on the 727 when the relative humidity varies over a wide range. The accurate guiding of the tape to the sensing heads depends upon the width of the tape. A change of .006 of an inch may cause misalignment errors.

Proper storage of the reel of the tape is, therefore, necessary to obtain satisfactory performance. If the tape is stored where the humidity ranges between 40% to 60% relative humidity, the design tolerances are maintained. If the tape is stored in an atmosphere outside the specifications, the probability of errors increases.

Temperature variations are secondary in comparison to humidity. If the tape is stored at about 70°F, no departure from the specified width should be observed. See 6.0 "Tape Handling."

2.4 CAPACITY AND SPEED

It is possible to write information in any of seven tracks across the face of the tape. Each track is independent of every other track and is associated with one read-write coil. Looking at the top of the tape, the tracks appear similar to Figure 1.

The tape is fed through the machine at a speed of 75 inches/sec. and the bits are written approximately every 67.2 usec. This means that about 200 bits may be written in one inch of space. One 2400-foot reel can contain the information on about 20,000 80-column cards.

Information may be placed on the tape in any configuration of bits desired. The configuration and interpretation is under control of the external circuitry to which the tape is attached.

The distance required to start and stop the tape motion must be mentioned when considering capacity. The combined distance required to stop and restart the tape motion is about 3/4 inch. Nothing may be written in this space because the tape is not moving fast enough to allow accurate writing or reading of bits. Therefore, the number of stops necessary during writing greatly affects the amount of space available for writing information.

3.0 PRINCIPLES OF STORING INFORMATION

3.1 MAGNETIC THEORY

A magnetic material is one that can be polarized or partially polarized when placed under the influence of a magnetic field. For every magnetic material, a B-H curve can be plotted showing the resultant flux densities in the material when placed in the influence of a varying magnetizing force. If a magnetizing force of ampere-turns (NI) is slowly increased in the positive direction, the resultant flux density in a magnetic medium would at first increase rapidly and then slowly attain a steady value of flux as shown in Figure 2. The phenomenon of attaining a steady value of flux density is designated as saturation of the magnetic material. When the ampere-turns are slowly reduced, the flux density also decreases, but at a different rate. This phenomenon is known as the hysteresis effect. When the magnetizing force is again zero, the flux density is not equal to zero, but is equal to some positive value, shown in Figure 2 as point A. The amount of magnetic flux remaining when NI is equal to zero, as denoted by the distance A-O in Figure 2, is the residual magnetism in the magnetic circuit.

If the ampere-turns are reversed by a reversal in current and the current magnitude is increased in the negative direction until saturation is again reached and then once again returned to zero, a negative resultant flux remains (point B, Figure 2). Thus, by employing suitable circuit techniques, a flux pattern of either positive or negative polarity can be impressed on a magnetic material.

The schematic sketch in Figure 3a illustrates the storing of bits of information. The magnetic circuit consists of the laminated ring, the air gap, a shim and the magnetic oxide on the tape. The ring is made of mu metal. Mu metal has a large mu * and low retentivity **. The gap has a mu of 1. The oxide has a mu of approximately 7-9, but has a high retentivity in comparison to the rest of the circuit. The half-mil gap is used to force the magnetic lines of force away from the head and into the magnetic material on the tape.

*Permeability is the measure of the ability of a magnetic material to conduct lines of flux. It is designated by the Greek letter mu (u) and is numerically equal to the ratio of the flux density to the magnetizing force. $u = B \div H$. The mu of air = 1.

**Retentivity is the capacity of a magnetic material to retain magnetism after the magnetizing force has been removed.

3.2 NRZI SYSTEM

The NRZI (non-return to zero) system of recording binary information on tape is a system in which the tape is continuously saturated in either the plus or minus direction. A change in saturation polarity is called a "one." No change within a given period of time is called a "zero."

The following is a simplified description of how the NRZI systems function.

The process by which information is stored is called "writing" and the process of detecting stored information is called "reading."

When switch 1 is closed at time T_1, current generator E_1 (Figures 3a and 3b) cause the current I_1 to flow through the coil as indicated and a flux path is set up as shown, using the right hand rule. Because this flux path extends into the magnetic material on the tape, the domains in the material line up in the direction of the flux path. If the tape is moving at a constant speed of 75 inches/sec., all the area passing under the write head becomes magnetized in the same direction.

If, at time T_2, switch 2 is closed and switch 1 is open, current generator E_2 causes current I_2 to flow through the opposite write coil as shown. This causes the flux path to be reversed and the domains in the magnetic material line up in the opposite direction. Because the switching time is very short, the tape moves only a very short distance during the time the reversal takes place. This process constitutes writing a binary one bit on the tape. If, at a time T_3, another reversal is made, then another binary one has been written.

If, at time T_4, no reversal is made, then a binary zero has been written. Thus, observe that if a reversal in flux is made at any time, a binary one bit is written and, if no reversal is made, a binary zero bit is written.

Figure 3c illustrates the magnetic material on the tape as being a series of tiny bar magnets placed end to end. Where the change in flux occurs, there are like poles; where no change occurs, there appears to be a long magnet.

The reading of a binary one is simple in principle. The reading circuits make use of the fundamental fact that voltage is induced in a coil whenever there is a time rate of change of the flux linking the turns of the coil. This principle can be stated in the following fundamental equation: $e = N d\phi/dt$.

As the tape is passed over the head, a voltage is induced in the windings on the head when a reversal of flux pattern is encountered. This voltage is taken from one coil and routed to amplifiers and storing circuits.

A binary one is sensed as the presence of a voltage pulse at the terminals of the coil. (This voltage pulse is produced by a flux change in either direction.) The absence of a voltage pulse (no change in flux) indicates a binary zero.

The information stored on the tape may be erased by saturating the magnetic material all in the same direction. This is done by a separate erase coil and head described in section 4.4.2.

The advantages of the NRZI system over a pulse system are:

a. High inherent density. Binary ones can be written closer together than in a pulse type system.
b. High output when reading. A maximum change of flux occurs from minus to plus saturation.
c. Simplified erasing technique. Erasing to saturation is simpler than erasing to zero flux.

4.0 PHYSICAL DESCRIPTION

The 727 magnetic tape unit is built on a frame about 2' x 2'2" x 5'3-3/4". Mounted on the front of the frame are the reels, vacuum columns, read-write and erase heads and the tape driving pulleys and capstans. The buttons and lights used to control the unit manually are mounted on a door forming part of the cover over the front. Figure 4 is a sketch of the machine front without covers and Figure 5 is a sketch of the configuration of the panel buttons and lights.

4.1 TAPE MOTION

Tape is transported from the left or file reel through the read-write and erase heads to the right or machine reel. Because the reels containing the tape are relatively sluggish in action, it would be practically impossible to start and stop the tape efficiently if it were driven directly from the reels. Therefore, a buffer storage area is provided in the form of vacuum columns below the reels. In each of these columns a loop of tape is retained and the tape is driven through the read-write and erase heads by a friction drive and pulley combination. As tape is drawn from one column, it is replenished periodically by rotating the associated reel in the proper direction. As tape is driven into the opposite column, the associated reel is periodically caused to turn in the correct direction to wind up the tape. The control of the reel motion and the reel drive will be discussed further on. Figure 6 illustrates the path of the tape from one reel to the other. The next paragraphs describe the mechanics of the tape transportation mechanism.

The right and left drive capstans turn continuously in the direction shown. To drive from left to right (forward), the right moving pulley fork pivots to the right squeezing the tape between the moving pulley and the rotating drive capstan. At the same time, the left moving pulley fork pivots toward the left drive capstan, but does not strike it.

To drive from right to left (backward), the left moving pulley fork pivots to the left causing the tape to be squeezed between the left moving pulley and the left drive capstan. At the same time, the right moving pulley moves toward the right drive capstan but does not strike it.

To stop tape motion, the moving pulley forks pivot in the opposite direction causing the tape to be squeezed between either the right or left moving pulley and the right or left stop capstan, respectively. If the tape is moving from left to right, it is stopped at the left stop capstan. If the tape is moving from right to left, it is stopped at the right stop capstan.

4.2 MOVING COIL ASSEMBLY

Figure 7 is a sketch of the linkage operating the moving pulley assemblies. The basic motion is imparted to the system by the moving coil. This coil is suspended in the field of a permanent magnet. Passing current through it causes it to move very rapidly either up or down, depending on the direction of current flow.

If the coil is caused to move upward, called the "start" position, the linkage causes both moving pulley forks to pivot toward their respective drive capstans. If

the coil is caused to move downward, called the "stop" position, both moving pulley forks pivot away from their respective drive capstans.

4.2.1 Forward-Reverse Magnet Assembly

For only one moving pulley to cause driving at a time, it is necessary to bias the linkage to the right or left. This is accomplished by using the forward-reverse magnet assembly.

When the forward magnet is energized, the linkage is biased to the right. When the moving coil is then energized in the upward direction, the right moving pulley makes contact with the right drive capstan but the left moving pulley is held away from its drive capstan. If the moving coil is energized in the down direction, the left moving pulley is driven against the left stop capstan but the right one is held away from its stop capstan.

The reverse happens when the reverse magnet, instead of the forward magnet, is energized. With power on, the moving pulley linkage is always in one of four definite positions: forward stop, reverse stop, forward start, reverse start. The normal position is considered to be forward stop.

4.3 SPLIT IDLERS--TAPE ALIGNMENT

To assist in maintaining proper alignment of the tape, the split idlers are used. They are located just to the right and left of the head assembly on the upper head plate. These split idlers keep the tape parallel to the main plate and a fixed distance from it, regardless of variation of width of the tape. To avoid too complicated an alignment system, it was preferred to maintain the alignment of one edge of the tape only and let the other move freely. Figure 8 is a view of the split-idler assembly. The front edge of the tape is held a fixed distance from the front plate by the stationary portion of the idler. The rear portion of the idler is free to slide on the shaft and is held in continual contact with the rear edge of the tape by spring tension. The entire assembly, shaft and all, rotates within sleeve bearings in the associated housing.

When the tape expands in width, it spreads the split idler. The track farthest away from the front edge of the tape is, therefore, most subject to misalignment when the tape expands or contracts laterally between the time of recording and the time of reading. If the distances of the two split idlers from the main plate are the same, a minimum of skew can be expected. (The problem of skew is discussed in section 13.3.) Measurements have shown that split idlers can be very effective in reducing skew to a minimum. Also, alignment between machines can be very closely controlled.

4.4 HEAD ASSEMBLY

The assembly generally referred to as the head assembly is made up of two vertical plates, the lower of which is stationary. The upper plate is built to move up and down under power. On the lower plate are located the read-write head assembly, the tape-break-light assembly, and the tape cleaner. On the upper plate are located the erase head, load point, and end-of-tape photo-electric-cell assemblies, the split idlers, and pressure pad.

To allow installation of tape by the operator and also to provide freedom of movement during high-speed rewind, the upper plate is moved upward leaving a gap of about 27/32 inch between the erase head and the read-write head assembly. During the time when tape is being transported through the machine for reading or writing, the upper plate is down causing the assemblies to be in close contact with each other.

4.4.1 Read-Write Head Assembly

The read-write head assembly contains the seven read-write heads in laminated form, one behind the other. The tape passes over the head assembly, oxide-side down. The entire head assembly is removable as a unit; connection to the read-write coils is made through a multi-pin plug at the bottom. The read-write head assembly should not be removed from the lower plate. It is set at the factory.

4.4.2 Erase Head

The erase head is located above and 3/8" to the left of the read-write head assembly. It consists of one large coil and core covering the entire width of the tape. It saturates all tracks in one direction during writing just ahead of the portion being written on. This process erases the information previously written. The head is kept very close to the read-write assembly vertically. A pressure pad is installed to the right of the erase head to keep intimate contact between the tape and the read-write head.

As previously stated, the erase head is mounted on the upper plate and moves up during high-speed rewind time and when the machine is in an unload status.

4.4.3 Load Point Sensing

To indicate the beginning of the usable portion of the reel of tape, a small reflective spot is placed on the tape (plastic side). This spot is 3/16" x 1" and is placed on the front half of the tape width, 1/32" from the edge. It should be located about ten feet from the physical end of the tape to allow sufficient wind-up on the machine reel.

This reflective spot is sensed by a photo-electric cell arrangement shown in Figure 9. The light from the front bulb is reflected from the spot to the photo cell directly to the right of it. This, in turn, operates control circuitry to stop the tape unit.

4.4.4 End-of-Tape Sensing

The end of the usable portion of the reel of tape is indicated by an identical reflective spot placed at least 14 feet from the physical end of the tape. This spot is placed on the plastic side of the tape 1/32" from the back edge. The rear bulb and photo cell sense this reflective spot in the same manner that the load point is sensed.

4.4.5 Tape Break

During high-speed rewind, the machine should stop if the tape breaks. An indication of tape breakage is provided by directing a light source from the under side of the tape to the end-of-tape photo cell. Tape normally passes between the light

source and the cell. However, if the tape breaks, the light source strikes the cell and stops the machine.

4.5 REEL DRIVE CLUTCHES

Each tape reel is mounted on a hub protruding from the upper front plate of the machine. This hub contains an expansion rim that grips the reel tightly when the locking screw in the center of the hub is tightened. The hub is mounted on a shaft extending through the upper front plate and to the rear. This shaft is driven by two continuously running three-phase motors through two magnetic powder type clutches; one for forward motion and one for reverse motion. A third clutch is used as a brake.

Figure 10 shows a single clutch unit. The innermost part is the rotor that is keyed to the shaft. Surrounding this part is the clutch housing with pulley grooves cut in its circumference to make it free to turn on the shaft. Within the clutch housing is embedded a coil, the connections for which are brought out to slip rings on one end of the housing. In the space between the rotor and the housing is a mixture of magnetic iron powder and graphite.

When current flows through the coil in the housing, flux is produced. It solidifies the iron and graphite mixture and causes the rotor and housing to be essentially locked together. Therefore, if the housing is made to turn continuously through pulley action from the motors, the rotor does not move with it unless current is flowing through the coil. As soon as current is caused to flow through the coil, the rotor begins to move with the housing and to turn the hub and reel at the front of the machine.

Because of the inductance of the coil, current in it builds up gradually and, because torque transmitted is proportional to current (and flux), a quite smooth acceleration is produced. This smoothness is essential because shock in the reel causes slippage of the tape on the reel, and eventual breakage. The magnetic powder clutch was selected here for its ability to produce quite smooth accelerations and large torques with relatively small control currents. The iron-graphite mixture does not wear the clutch parts but only tends to polish them. To hold the iron-graphite mixture in the vicinity of the flux gap, a series of labyrinth type ridges were designed into the clutch parts. These ridges assist centrifugal force to return the powder back to the magnetic gap.

All three clutches are mounted on the same shaft with all rotors keyed to it. The front clutch has a stationary housing and thus serves as a brake when necessary. The middle clutch housing is driven in a clockwise direction and serves as a forward drive. The rear clutch housing is driven in a counterclockwise direction and serves as a reverse drive.

Control of the clutch energization is discussed under section 7.0.

Each brake may be released when the machine is unloaded by depressing the release button located below and to the left of the file reel. The left button causes de-energization of the left brake clutch and the right button causes de-energization of the right brake clutch.

4.6 VACUUM COLUMNS AND VACUUM-OPERATED SWITCHES

The vacuum columns are vertical columns of rectangular cross section. The inside dimensions are 2-1/2" x .510 (+ .002", - .000"). The front face of the vacuum column is transparent so that tape can be observed at all times. The top of the vacuum column is open and the lower end is connected to a manifold leading to a vacuum pump that maintains a vacuum of about eight inches of water. Tape is allowed to hang in the columns in such a way that the oxide surface of the tape strikes the sides of the column only at the edges of the semicircular loop formed. Because of this action, vacuum is maintained below the loop and atmospheric pressure above it. This difference in air pressure is sensed by vacuum-operated switches located behind each column. Pressure is transmitted to each switch via a short tube emerging from a hole in the column. Each column contains two such holes and associated switches; one located about 1/3 of the column length from the top and the other about 1/3 of the column length from the bottom.

The vacuum columns act as a storage area for the tape, allowing tape to be moved across the head at random, without having to turn the reels simultaneously. They also put a constant tension on the tape, preventing tape buckle at the head when starting and stopping.

The tape reel drive clutches are controlled with relay circuitry to produce the following forward motion results. As tape is pulled past the read-write head by the drive capstan it is pulled out of the left column. When the loop of tape is pulled above the upper vacuum switch in the column, the file reel forward (left down) clutch is energized and the reel turns in a clockwise direction causing more tape to be fed into the left column. As soon as the loop is again below the upper switch, the left down clutch is de-energized and the brake applied. This action causes the loop to oscillate about the upper switch as long as tape is moving past the read-write head.

At the same time, tape is continually being fed into the right column from the read-write head area. When the loop of tape in this column falls below the lower switch, the machine reel forward (right up) clutch is energized and the reel turns in a clockwise direction to pull tape out of the column and wind it on the reel. As soon as the tape is again above the lower switch, the right up clutch is de-energized and the brake applied. This action results in the tape loop's oscillating about the lower switch in the right column. Action of the reels and the tape in the columns is just the reverse when tape is moving in the reverse direction.

Generally speaking, whenever the tape is between the two vacuum column switches the associated reel is stopped (neglecting overshoot); when the loop is above the upper switch, more tape is fed into the column and, when it is below the lower switch, tape is pulled from the column.

The vacuum column switch is shown in cross section in Figure 11. The presence of a vacuum causes the diaphram to move in a direction that transfers the contacts of the switch. For greater reliability, two sets of contacts are used in parallel.

A bellows-type vacuum switch is mounted on the manifold between the two columns. It is used to prevent normal machine functions until the vacuum is maintained at a certain level. This is named the vacuum safety switch.

At the bottom of each vacuum column, separating the column from the manifold, is a flapper valve. This valve is similar to a door, held open under spring tension. A rush of air down the column strikes the flapper valve and closes it. Thus, the flapper valve and its associated microswitch, give an indication as to whether tape is in the vacuum column. When tape is in the column, very little air passes down the column and spring tension pulls the flapper valve open. When tape is removed from the column, or is broken, the rush of air downward closes the flapper valve and its microswitch.

Adjustments of all the switches associated with the vacuum columns are covered under "Removal, Assembly and Adjustment Procedures."

4.7 MOTOR DRIVE

The reel drive clutches are driven by two 1/4 HP, 3ø, 220v, AC motors (1140 RPM), one providing forward motion and the other providing reverse motion. Figure 12 is a front view of the drive motor and pulley arrangement.

The forward drive motor is located in the lower right-hand corner and is connected to the two center clutches by two V-belts adjacent to each other.

The reverse motor is located in the lower left-hand corner and is connected to the two rear clutches in the same manner as the forward motor.

To provide very fast motion of the reels during high-speed rewind, an additional motor (1/12 HP, 3ø, 208v, AC, 3450 RPM) is provided in the upper left hand corner. This motor is coupled to the file reel shaft and during normal tape motion is merely turned with the file reel shaft. However, when the machine goes into a high-speed operation, this motor drives the file reel shaft at a high rate of speed. At this time, none of the magnetic clutches are energized.

The capstans are driven by a 1/10 HP, 3ø, 220v, AC motor running at 1300 RPM. This motor is turned off when the capstans are retracted.

4.8 TIME DELAY

The time delay and its drive motor are located on the relay gate. This mechanism delays machine operation at the end of a high-speed rewind to allow the reels time to stop before tape is loaded into the columns. When the motor starts running, it drives an operating arm by means of a reduction gear train. After a given time the arm operates a microswitch, referred to as the time delay point. As long as power remains on the motor, the operating arm holds the time delay point closed. When power is removed, the arm returns to a home position under spring tension. The length of the time delay can be set with a calibrated dial on the front of the assembly.

4.9 CAPSTAN RETRACTING MECHANISM

While unloaded and while high-speed rewinding, the drive capstans must be retracted to allow free passage of the tape past the read-write head area. This operation is accomplished with a linkage operated by a solenoid at the right of the machine (Figure 13).

When this solenoid is energized, the horizontal shaft is rotated counterclockwise (as viewed from the left side) causing the arm and fork at (4) to push the capstan mechanism to the rear. Also attached to the solenoid armature is a dash-pot arm to pull the plunger in a dash pot, cushioning the action of the capstans. Inside the dash pot is a coil spring that is compressed when the capstans are retracted. This spring is the source of power to extend the capstans.

The horizontal capstan shaft is driven from the solenoid through a torsion spring. When the solenoid is unlatched, the dash-pot spring turns the horizontal shaft, and, through two torsion springs, extends the capstans. Located on the horizontal shaft are two capstan "out" microswitches and one capstan "in" microswitch. They indicate electrically the positions of the capstans.

The solenoid has a latch to hold the solenoid plunger down after it is pulled down. A latch magnet is provided to release the latch and the plunger when desired. The pulleys driving the capstans remain stationary; the shaft is merely pushed in and out.

A definite sequence of operation is necessary when extending the capstans under electrical control. The retracting solenoid must first be energized to remove the pressure from the latch pin. The latch magnet can then retract the latch pin. While the pin is being held out of the way, power is removed from the retracting solenoid allowing the capstans to extend. Finally, the latch magnet is de-energized.

4.10 HEAD-RAISING MECHANISM

The mechanism that raises the upper portion of the head assembly is directly behind the upper front plate. It consists of a screw shaft, driven from a friction clutch and drive chain by a small take-up motor. The take-up motor is mounted above and between the two clutch shafts.

When the motor is operated in one direction, the screw shaft turns in a clockwise direction causing the upper head assembly to move upward. When the motor is operated in the opposite direction, the shaft turns counterclockwise and lowers the assembly. Microswitches are operated at both limits of travel to indicate the position of the head cover assembly.

In addition to operating the screw shaft, the motor is geared to each of the brake clutch housings so that, when the head is being raised, the left stop clutch housing is rotated in a counterclockwise direction and the right stop clutch housing is rotated in a clockwise direction. The brake clutches are energized at this time and the reels are driven in the above mentioned direction. This causes tape to be pulled from both columns. The opposite occurs when the head assembly is lowered and tape is lowered into the columns.

4.11 REEL DOOR INTERLOCK

Located in the lower left-hand corner of the reel door is an interlock switch that is closed when the door is closed. When the door is open, operation of the reel drive motors is prevented. For convenience of the customer engineer, this switch can be closed with the door open by pulling out the operating plunger.

4.12 FILE PROTECTION

A device is provided to prevent writing on a reel of tape if so desired. This device consists of a groove cut in the rear side of the file reel and an associated ring which fits into the groove. If the ring is not placed in the groove, writing is suppressed but reading is allowed. If the ring is placed in the groove, both reading and writing may occur.

To sense the presence or absence of the ring, a pin protrudes from the upper main plate. The pin is connected to the armature of a duo relay mounted directly behind the upper main plate. If a ring is in the groove of the file reel, the pin is pushed to the rear, causing the relay armature to be sealed. This action transfers the relay contacts to energize the relay and also allow writing to occur. If the groove in the reel is empty, the pin is not actuated and the relay is not energized; normal writing is prevented.

4.13 POWER CONSIDERATIONS

All external power is brought into the tape unit through a male Cannon plug located at the lower rear right-hand corner of the tape unit. Power may be jumpered to other tape units by connecting the female Cannon outlet located beside the male inlet plug. Drive motor operation requires 3ø , 208v, AC power. One phase of the 3ø supply is used to operate the 48v DC supply located within the tape unit. The 48 volts is necessary for relay operation.

The +270v, +140v, -60v, -130v, -270v, and +40v are brought from external supplies. The 40v is used only to light a thermal light in the event that the temperature within the unit becomes excessive.

4.14 MACHINE REEL SENSING ARM

The sensing arm rides on the surface of the tape on the machine reel, and has an associated contact. When more than a half inch of tape is on the machine reel, the contact is open; when less than one-half inch of tape is on the machine reel, the contact is closed.

The purpose of this arm and contact is discussed under "High-Speed Rewind" in section 10.0.

5.0 PANEL BUTTONS AND LIGHTS (FIGURE 5)

Located on the reel door of the tape unit are the operating buttons and lights. These may be operated if the door interlock switch is transferred.

Select Switch. This switch is rotary type, located in the center of the group. It is used to set the tape unit to any one of the ten addresses. If the switch is set on address 1, the unit is not selected unless address 1 is selected, and so forth.

Select Light. The select light is turned on when the tape unit is selected and remains on until the selection is removed.

Start Button. Depressing the start key causes the machine to be in a ready condition if : (a) tape has been previously loaded into the column, (b) the reel door interlock is closed, and (c) the tape unit is not in the process of finding the load point (rewind or load operation).

Ready Light. This light is on if the machine is in a ready status as described above. Manual control is indicated when the ready light is off provided the tape unit is not rewinding or loading and the reel door is shut.

File Protection Light. This light is turned on automatically by mounting a protected reel onto the unit. It is on if no file reel is mounted.

Load-Rewind Button. If the reel door is closed, depression of this key causes loading of the tape into the columns and searching for the load point. If the tape has been unloaded manually in the fast rewind section of the tape, depressing this key executes a high-speed rewind before the above operation takes place. This button is inoperative unless the tape unit is under manual control.

Unload Button. Operation of this button removes the tape from the columns and raises the upper head assembly regardless of the distribution of tape on the two reels. If the tape is not at load point when the operator wishes to change it, a load-point search should be initiated first by depression of the load-rewind button. The tape indicator is reset by depression of the unload button. This button is inoperative unless the tape unit is under manual control.

Tape Indicator On Light. This light is turned on whenever the tape indicator is turned on by external control when reaching a tape mark while reading, or by reaching the physical end of tape while writing. It may be turned off under external control or by depression of the unload button.

Reset Button. This button resets all controls (except the tape indicator) and, in general, stops any tape operation that has been initiated.

Fuse Light and Thermal Light. The fuse light and thermal light are located on the inside of the door assembly. The fuse light is nearest the door latch and lights when either the AC or DC fuse bail trips. The thermal light lights when the tem cop at the top of the tube panel operates from over-heating.

6.0 TAPE HANDLING

Because foreign particles can reduce the intensity of reading and recording pulses by increasing the gap between the tape and the head, take the utmost care to protect the magnetic tape from dust and dirt.

1. Keep the tape in a dust-proof container whenever it is not in use on a tape unit. During loading, take the tape directly from the container, and after unloading, place the tape directly in the container.
2. While the tape is on the machine, keep the container closed and put it in some location where it is not exposed to dust or dirt.
3. Store tapes in some type of cabinet elevated from the floor and away from sources of paper or card dust. Doing this should minimize the transfer of dust from the outside of the containers to the reel during loading or unloading operations.
4. Do not use the top of tape unit as a working area. Placing materials on top of the units exposes them to heat and dust from the blowers in the unit. It might also interfere with the cooling of the tape unit.
5. When identifying tape reels, use a material that can be removed without leaving a residue. Adhesive stickers, easily applied and removed, are satisfactory. Usually, they can be prepared beforehand and applied during the loading procedure. Never alter identification by changing labels with an eraser! A card holder has been incorporated in the design of the new reel.
6. Place load points and reflective spots on tapes with care. Properly align and press them tightly on the tape with the back of the fingernail. It is best to do this while the tape is loaded on a unit. If this is done away from the unit, keep the unrolled end off the floor and away from dusty areas.
7. Inspect containers periodically. Remove any accumulated dust by washing with a regular household detergent.
8. When necessary to clean tape, gently wipe the tape with a clean, lint-free cloth moistened with an approved solvent. Do not use carbon tetrachloride on plastic reels.

Recorded information comes within .020" of the edge of the tape. Proper operation relies on the edge's being free from nicks and kinks. To accomplish this:

1. Handle the reels near the hub whenever possible, if there is resistance in removing a reel. If this resistance occurs, press from the rear of the reel with the hands as near the hub as possible. Under no circumstances should the reel be "rocked" by grasping the outer edge.
2. Carefully avoid pinching the reels or contacting the exposed edge of the tape.
3. When mounting, push the reels firmly against the stop on the mounting hub to insure good alignment.
4. Always take special precaution to make sure the hub has been tightened after the reel has been mounted.
5. When placing the tape on the take-up reel, carefully align the tape to prevent damaging the edge on the first few turns. If there is a spring, the tape should be inserted (without folding back) under the spring in the direction that the reel turns.
6. When winding the tape to load point, rotate the machine reel with the finger near the hub and on the reel. Rotating the reel with the finger in the cutout nicks or curls the guiding edge of the tape.
7. Always place sponge rubber grommets or special clips on stored reels to prevent the free end from unwinding in the container.

8. If a tape break occurs, divide the reel into two smaller reels. Splicing is not recommended. If it is necessary to make a temporary splice in order to recover information, be sure to use special low cold flow splicing tape.

9. Dropping a reel can easily damage both the reel and the tape. General use of a reel and tape after it has been dropped is usually unsatisfactory.

10. Never throw or mishandle reels, even while they are protected in their containers.

Magnetic tape is sensitive to changes in humidity and temperature. Note the following recommendations.

1. If at all possible, store the tape where it is to be used, e.g., in the calculator room. Location of tape storage near the tape drives reduces both handling and variations in atmospheric conditions.

2. The atmosphere should be controlled between the following limits:
   (a) relative humidity 40-60%
   (b) temperature 65°-80°F

3. If the tape must be removed from the calculator atmosphere, hermetically seal it in a plastic bag. If the tape is not hermetically sealed then, before re-use it must be returned and allowed to remain in the calculator atmosphere for a length of time equal to the time it was away from the room. Twenty-four-hour conditioning is necessary if the tape has been removed for a time greater than 24 hours.

When customers ship magnetic tape, the following procedure is advisable.

1. Pack the tape and reel securely in a dust proof container.

2. Hermetically seal the container in a plastic bag. (Ordinary plastic bags that can be sealed with a hot iron should be available from local merchants.)

3. Obtain additional support by enclosure in individual stiff cardboard shipping boxes.

For long-term storage, take the following precautions.

1. Provide proper mechanical support for the reels by using the dust proof containers.

2. Enclose the reel and container in a hermetically-sealed moisture-proof plastic bag.

3. Store in an area of constant temperature. Either freezing or excessive temperatures could harm the tape. A temperature between 40° and 120°F is satisfactory.

The following are points of general tape-handling information.

1. The procedures outlined above apply to handling tape in a 701 installation as well as 702 and 705 installations.

2. Customer engineers and other IBM personnel should take special precautions to follow the tape handling recommendations to show, by example, the care required to insure good tape performance.

3. Replace any tape arriving at the customer's installation in unusable condition and return the faulty tape to the factory. To aid the factory in its inspection, ship the tape according to the shipping instructions outlined above.

4. Use discretion about smoking in the vicinity of tape because it adds to the dirt problem. A hot ash could cause serious trouble with a reel of tape.

7.0 LOAD-REWIND OPERATION

Initiate a load-rewind operation by pressing the load-rewind button. Doing this always has the same end result; the tape is moved until the load point stops beneath the load-point photo cell.

In this discussion of a load-rewind operation, assume the following initial conditions:

1. The power cable is connected to a control unit as a source of power. The power is turned off.
2. The tape drive unit is unloaded (the normal condition with power off); the capstans are latched in and the head cover is up.
3. No reels of tape are on the machine.

The following is a word sequence of bringing up power and load rewinding.

Step 1. Turn on power in the unit controlling the tape drive. Doing this supplies AC power to the tape drive, which starts filaments, blowers, fan, and 48v DC supply.

Step 2. After a five-minute warm up period, DC supplies to the tape drive come up. A "power on" relay picks to indicate the presence of these supplies. The machine can now be operated.

Step 3. Mount the full reel of tape on the file reel, and thread the tape past the the idlers and read-write head assembly over to the machine reel. The reel brakes may be released by pressing the buttons below the file reel. Wind several turns of the tape manually on the machine reel until the load point is well to the right of the head assembly. Close the reel door and press the load-rewind button.

Step 4. The vacuum motor and time-delay motor start turning.

Step 5. At the end of the time delay (about five seconds) the vacuum is at operating strength. The take-up motor starts turning in a reverse direction, lowering the head cover assembly and lowering the tape into each column.

Step 6. When three conditions are satisfied, the take-up motor is turned off. These three conditions are: (1) the head cover is all the way down, (2) tape is in the right column, and (3) tape is in the left column. The drive capstans start turning and are extended.

Step 7. When the "capstan out" microswitches indicate that both capstans are fully extended, the machine goes into a reverse-start status, and tape moves in a reverse direction until the load point is sensed. When the start button is pressed, the machine is ready for use.

The following is the actual relay operation for load-rewind. The sequence chart and the wiring diagram (section 18.0) can be used with this description. Locations of relays are denoted by the system diagram page number and the corresponding letter in the wiring diagram.

7.1 INITIAL CONDITIONS

When external power is first turned on, the 48v DC supply is energized from phases 1 and 2 of the 3ø, 208v, AC supply, and the blower and fan motor are energized from phases 2 and 3 (75.10.02). Filament power is applied through the filament transformer (75.10.05) from the 236v regulated external supply.

The following relays can pick with the 48v DC supply, because the tape unit is assumed to be unloaded.

Systems	Sequence of Operation	Conditions	Remarks
	R21, R26, unload, are latched.		These relays were latched the last time the machine was unloaded.
05D	Pick R11, R22, unload.	R21-4n/o	
01H	Pick R14, photo light.		Circuit through the load point, tape end, and tape break light.
05F	Pick R8, head cover not down.	Head cover down micro-switch	
06H	Pick R13, clutch transfer.	R11BU	Vacuum column switches have no control over reel clutches.
05G	Pick R7, cap-stans in.	Capstans in microswitch	
10.01	Full power to both stop clutches.	R1AUn/c, R4ALn/c R1BUn/c, R4BLn/c	Power to stop clutches can be interrupted by pressing reel release button.

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After a five-minute warm-up period, DC supplies are available from the control unit.

01C	Pick R17, power on.	When all DC supplies are available from control unit	
06H	Pick HD3, phase 3.	R17-4n/o	
02J	Reset R/W status tgr. to read status.	R20-3n/c	
02J	Reset tape indi-cator tgr.	R22-4n/o	
02E	Manual start line up	R22-3n/o, R7AUn/o R6BUn/c	Keep the moving pulleys away from stop capstans

Systems	Sequence of Operation	Conditions	Remarks
			so tape can be threaded on the machine easily.
		. . . .	
	Thread tape on machine.		
		. . . .	
02A	Push load-rewind button.		
03L	Pick R40, rewind PU	R42-3n/c, relay driver (75.08), manual load-rewind line and read status.	R40 has no hold circuit.
04C	Pick R2, load-rewind.	R40-1n/o	
05C	Pick R3, R31, load-rewind. LT R21, R26, unload.	R2BLn/0	
06H	Pick HD4, vacuum mtr.	R26-1n/c	
10.02	Start vacuum mtr.	HD4 pt.	
05D	Drop R11, R22, unload.	R21-4	
04C	Hold R2, load-rewind	R2ALn/o, caps out micro-switches.	
06H	Hold R13, clutch transfer.	R3BU	R13 holds through a different point.
01H	Shunt load pt. and tape-end lights.	R3AU	
04D	Pick R5, R6, start slow rewind and HD7, time delay.	R2AU, reel-arm switch	
04D	Hold R5, R6, HD7.	R5ALn/o	

Systems	Sequence of Operation	Conditions	Remarks
75.10.02	Time delay mtr. starts.	HD7 pt.	
05E	Pick DP1, take up mtr. reverse.	R6BLn/o	Prepare to run take-up mtr. in reverse.
06G	Pick HD8, retract capstans.	R6AUn/o	
06B	Energize capstan retracting solenoid.	HD8 pt.	Prepart to extend capstans.
06B	Energize magnet latch.	R6AL	
011	Pick R35, R36, rewind status.	R31-4n/o	
011	Hold R35, R36.	R35-1n/o	Hold until load point is reached.
02E	Drop the manual start line.	R6BUn/c	

The above operations all take place within a fraction of a second after the load-rewind button is pressed.

. . . .

When sufficient vacuum is obtained, the no-vacuum switch and the flapper valve switches transfer causing the following action:

04B	Pick R1, R18, run.	No vacuum switch	
05G	Pick R9, R10, tape out of columns.	Flapper valve micro-switches	
06H	Pick HD1, phase 1 and HD2, phase 2.	R1AL	Reel drive motors start.
04D	Pick R4, clutch.	R1BL, R7AL, R21-2n/c and R2 hold circuit.	
75.10.01	1/2 power applied to right stop clutch.	R4BLn/o	

Systems	Sequence of Operation	Conditions	Remarks
02E	Manual start line goes up.	R9BL, R10BL, R31-6	Start to the moving coil is incidental at this time.

. . . .

The time-delay point closes.

05E	Pick HD6, take-up mtr. start.	Time delay point	
75.10.02	Start take-up mtr.	HD6 pts.	
75.10.01	1/2 power applied to left stop clutch.	R4ALn/o, R12ALn/c, R7BL, time delay pt., R7AUn/o	With 1/2 power on both stop clutches, the take-up mtr. spills tape into the columns.

When tape gets in either column (assume the left column), its flapper valve opens, dropping R9. The manual start line goes down (02E), pushing the left moving pulley up against its stop capstan, pinching the tape. The tape then goes into the other column, dropping R10. If tape were not pinched by dropping R9, the left column would take all the tape spilled from both reels.

05F	Drop R8, head cover not down.	R9BU, R10BU, head cover down micro-switch	Head cover is down and tape is in both columns.
05E	Drop HD6, take-up mtr. start.	R8BU	Stop the take-up mtr.
06G	Drop HD8; retract capstans.	R8AUn/o	
06H	Pick DP2, capstan mtr.	R8AUn/c	
75.10.02	Start capstan mtr.	DP2 pts.	Capstans start turning.
06B	Drop capstan retracting solenoid.	HD8 pts.	Capstans start to extend.
05G	Drop R7, caps. in.	"Caps in" microswitch	
05E	Drop DP1, reverse field.	R7AU	
04D	Drop R4, clutch.	R7AL	

Systems	Sequence of Operation	Conditions	Remarks
75.10.01	Full power to both stop clutches.	R4 pts.	
04C	Drop R2, rewind.	"Caps out" microswitches	Both capstans are fully extended.
05C	Drop R3, R31, rewind.	R2BL	
04D	Drop R5, R6, start slow rewind, and HD7, time delay.	R2AU	
75.10.02	Stop time delay mtr.	HD7 pt.	Time delay arm returns to home position.
06H	Drop R13, clutch transfer.	R3BU	Vacuum column switches now control reel clutches (75.10.01). These switches keep tape in the center third of each column from now on.
06B	Drop retracting solenoid latch.	R6AL	
011	Pick R33, reverse.	R31-2n/c	
02J	Manual reverse line comes up.	R33-2	Energize the reverse magnet. De-energize the forward magnet.
011	Pick R34, start.	R33-1	
02E	Manual start line comes up.	R34-1	Energize moving coil in the start direction.

. . . .

Tape moves in the reverse direction until the load point is sensed at the load-point photo cell. As the tape passes under the load-point photo cell, the light is reflected to the cell. The cell output is a negative shift and is applied to an inverter (75.04). The output of this inverter is again inverted and pulls over a 20 ms SS_T. The left output of this SS_T, "not arriving at load point" goes down, dropping the lower leg of AND circuit F27 (75.05.01). This puts the moving coil in the stop position and stops the tape with a reverse-stop status. At this same time, the right

output of the SS_T goes up, allowing the relay driver at 5F (75.04) to conduct, latch picking R42, load point (75.09.03L).

Systems	Sequence of Operation	Conditions	Remarks
011	Drop R35, R36, rewind status.	R42-1	
011	Drop R33, reverse.	R35-2	
011	Drop R34, start.	R33-1	
02E	Drop manual start line.	R34-1	

The moving coil has already been put in a stop status by the line "not arriving at load point." At the end of the 20ms SS_T, the line goes up again. By that time, however, the manual start line has gone down, keeping the moving coil in a stop status. During the 20ms period, the status is changed from reverse stop to forward stop.

For reference purposes, low-speed rewind and high-speed rewind sequence charts are includes as Figures 31 and 32 at the end of this manual.

8.0 MOTION CONTROL

The mechanical linkage used to provide motion of the tape is described under "Physical Description." The operation of this linkage is dependent on energizing the moving coil in either direction. The control of this operation is covered in the following descriptions.

8.1 MOVING COIL CIRCUIT

The direction of current flow in the moving coil is controlled by the start and stop lines. When the start line is up, the stop line is down and electrons flow in the moving coil from right to left (75.05.02). This flow causes the moving coil to move upward and tape begins to move. The simplified schematic on Figure 14 shows the following operation of the circuit. The start line is fed to the I_E (4) and I_F (8) and both tubes begin to conduct. When this line goes up, the output of (4) is fed to the I_M's (3) and (6). (6) is biased below cut-off normally so the negative shift does not affect it. Tube (3) is driven to cut-off. Tube (8) begins conducting and its plate output is tied to the K_A's (10) which is driven to cut-off. Referring to the left side of the schematic, the stop line is down so tube (1) is cut off as well as tube (7). Tube (2) is driven into conduction. Notice that the plate circuit for these 2 I_M tubes is actually a 450-ohm resistor and the moving coil in series with the cathodes of (9). Therefore, electrons flow from ground through tube (2), the 450-ohm resistor, moving coil (right to left), the cathode and plate of tube (9), to +140v. A heavy initial current is needed through the moving coil to produce fast action. This heavy current is obtained with the $2I_M$ at tube (5) which is AC coupled to the I_E at (1). It causes two-to-three-times normal current to flow initially because it provides a parallel circuit with tube (2). Normal current is about 50 ma. The time constant of the input of tube (5) determines the length of time the large current flows--about 12 ms.

When the start line goes down, the stop line goes up and electrons flow from left to right through the moving coil. This flow causes the moving coil to move downward and the tape to be stopped. The action of the circuit to cause this stopping is just opposite to the start action. In this case, the electron flow is from ground through tube (3), the 450-ohm resistor, moving coil (left to right), the cathode and plate of tube (10), to +140v.

8.2 FORWARD-REVERSE CONTROL

The direction of motion of the tape is dependent on the position of the forward-reverse magnet assembly. The magnet assembly is shown on 75.05.02.

If the tape unit is in forward status, the reverse line is down, causing the I_B at T02J-6 to be cut off so that no current can flow through the reverse magnet. The divider output of the I_B is up and is connected to the I_B at T01J-6 which therefore conducts through the forward magnet.

To move tape backward, the reverse line comes up and the opposite action occurs.

9.0 UNLOAD OPERATION

To remove a reel of tape and mount a new reel, the unit must be in an unload status. Unload status may be obtained by pressing the reset button and then the unload button on the front panel. (Pressing the reset button is only necessary if the ready light is on.) The tape is pulled from the columns. The head cover is raised, and all motors except the fan and blowers are stopped. The following sequence takes place:

Systems	Sequence of Operation	Conditions	Remarks
75.09.04A	Press unload button. Latch pick R21, unload.	R20-1n/c	Door must be closed. Reset button dropped R20.

The R21-1 points open the circuit to R20, start, so the machine cannot be placed in a ready status when unloaded.

05D	Pick R22, 11, unload.	R21-4	
06H	Pick R13, clutch transfer.	R11BU	Control of clutches removed from vacuum column switches (10.01).
02J	Reset the TI tgr.	R22-4	
01H	Remove shunt from tape-break light.	R22-1	
03L	Pick R19, drop load point.	R22-5 (02J)	
03K	LT R42, load point.	R19-1	
03K	LT R41, tape break	R22-6	If R41 has been latch picked.
06G	Pick HD8, retract capstans.	R11BL, R6AUn/c R22-8, R8AUn/c	
06B	Capstans retracting solenoid.	HD8 pt.	Capstans retract and latch.

. . . .

Systems	Sequence of Operation	Conditions	Remarks
05G	Pick R7, caps in.	Caps in microswitch	
04D	Pick R4, clutch.	R7AL, R21-2n/o	1/2 pwr. to both stop clutches.
05E	Pick HD6, take-up mtr. start.	R7AUn/o	Take-up mtr. starts in forward direction.
		. . . .	
05F	Pick R8, head cover not down.	Head cover down micro-switch	When head cover starts up.
02E	Manual start line up.	R8BL	Start to moving coil.
06G	Drop HD8, retract capstans and DP2, capstan mtr.	R8AUn/c	Stop the capstan motor.
		. . . .	
05G	Pick R9 and R10, tape out of columns.	Col. flapper valve micro-switches	Tape out of both columns.
04A	Hold R1, R18, run.	R11AL	
05F	Latch pick R26, unload stop.	R11AUn/o, h.c.-up micro-switch, R10AU, R9AU, R5 BL, R6BLn/c, R7AUn/o	Indicates tape is out of both columns, and head cover all the way up.
05E	Drop HD6, take-up mtr. start	R26-2	Take-up mtr. stops.
06H	Drop HD4, vacuum mtr.	R26-1	Vacuum mtr. turned off.
04A	Drop R1, R18, run.	No vacuum switch	Vacuum mtr. has stopped.
06H	Drop HD1, HD2, phase 1, phase 2.	R1AL	Stop forward and reverse motors.
04D	Drop R4, clutch.	R1BL	Full power applied to both stop clutches.

The machine remains in unload status until the load rewind button is pressed.

10.0 HIGH-SPEED REWIND

When a tape has been completely written or read, the bulk of the tape is on the machine reel. Because time is a prime factor in the operation of this unit, it is best to accomplish a rewind to the file reel as fast as possible. A high-speed rewind may be initiated when at least one-half inch of tape is on the machine reel.

Assume these initial conditions: tape in both columns, head cover down, capstans extended and turning, and more than one-half inch of tape on the machine reel.

Systems	Sequence of Operation	Conditions	Remarks
02A	Push load-rewind button and pick R40, rewind PU.	R42-3n/c, relay driver (75.08), manual-load-rewind line, and read status.	Must press reset button first if ready light is on.
04C	Pick R2, load-rewind.	R40-1	
04C	Hold R2.	R5AL	
05C	Pick R3, R31, load-rewind.	R2BL	
06H	Pick R13, clutch transfer.	R3BU	Remove control of reel-drive motors from vacuum-column switches.
01H	Turn on tape-break light.	R3AU	Dim the tape-end and load-point photo lights.
06G	Pick HD8, retract capstans.	R3BL, R6AUn/c, 7AUn/c	HD8 pts. start retracting the capstans.
011	Pick R35, R36; rewind status.	R31-4	
03K	Rewind-status line up.	R36-1n/o	
		. . . .	
05G	Pick R7, capstans in.	Caps in microswitch	Capstans fully retracted.
03K	Rewind interlock line up.	R7BU, R36-1n/o	Condition tape-break photo light.

Systems	Sequence of Operation	Conditions	Remarks
04D	Pick R4, clutch.	R7AL, R2 hold circuit	1/2 power to stop clutches
05E	Pick HD6, take-up motor start.	R5AU, R6BL, R7AUn/o	Start the take-up motor. Start raising the head cover, and turning the reels to pull tape from the columns.
06G	Drop HD8.	R7AUn/c	The capstans remain retracted because of the mechanical latch.
		. . . .	
05F	Pick R8, head cover not down.	Head cover down microswitch.	Head cover has just started up.
06H	Drop DP2, capstan mtr.	R8AUn/c	Stop the capstan motor.
02E	Manual start line up.	R8BL	The unit is now in a forward-start status, placing the moving pulleys away from the stop capstans.
		. . . .	
05G	Pick R9, R10, tape out of columns.	Flapper valve microswitches.	Tape out of both columns.
04A	Hold R1, R18, run.	R3AL	
05F	Pick R12, high speed DP3, rewind mtr.	R11AUn/c, head cover up microswitch, R10AU, R9AU, R5BL, R6BLn/c, R7AUn/o.	Indicates tape out of both columns and head cover all the way up.
05E	Stop take-up mtr.	R12BU	
10.01	Remove power from both stop clutches.	R12AL, BL	No power on any of the six clutches.
10.02	Start the rewind mtr.	DP3 A, B	Rewind tape at high speed until 1/2 inch is left on machine reel.
		. . . .	

Systems	Sequence of Operation	Condition	Remarks
04D	Pick R5, R6, start slow rewind, and HD7, time delay.	Arm switch	Start time delay motor.
05F	Drop R12, high speed, and DP3, rewind mtr.	R5BL	Turn power off rewind mtr.
10.01	1/2 power to right stop clutch.	R12BL	Start slowing down. No brake on left stop clutch.
05E	Pick DP1, take-up mtr. reverse.	R6BLn/o	Prepare to lower head cover.
06G 06B	Pick HD8, retract caps. Pick retracting solenoid latch.	R6AUn/o R6AL	Prepare to extend capstans.
05E	HD6, take-up mtr.	Time delay point	By this time, tape has been braked to a stop.

From this point on, the sequence of events is identical to slow-speed rewind, and the operation terminates when load point is reached. See section 7.0 and also the high-speed rewind sequence chart at the end of this manual (Figure 32).

11.0 MISCELLANEOUS

11.1 CHARTS

Systems pages 7X.01.02 through 7X.06.02 contain charts showing pluggable unit locations, cable connectors, fuses, and relays.

11.2 SELECT AND READY 75.01

A tape unit is ready for selection when the tape has been loaded into the columns, the reel-door interlock is closed, the unit is not rewinding, and the start key has been pressed. These conditions are indicated by the plus status of the lower input to AND circuit A12. The center leg of AND circuit A12 goes down for 20ms when the load point is sensed at the completion of a rewind operation. This allows time for the change in status from a reverse stop to a forward stop before the unit can be ready.

The third input is up when the external select line corresponding to the setting of the select switch is up. The output of AND circuit A12 becomes the select and ready line. This line must be plus in order to operate the tape drive from the control unit, with the exception of the tape-indicator control.

The select line is plus when the external select line corresponding to the setting of the select switch is up, regardless of the ready condition. The select line causes the select light to come on through the I_L, and also conditions the tape-indicator control.

11.3 READ-WRITE STATUS 75.02

Set Read Status

"Set read status" is externally generated. It is combined in AND circuit C5 with "select and ready" and the resulting positive shift turns off the read-write-status trigger. This trigger indicates a read or write status of the tape unit. If the unit is already in read status, the trigger is off. The left output of the read-write status trigger combines with "select and ready" in AND circuit A35, to bring up "select, ready and read." This response is returned to the control system indicating that a tape unit is selected, ready, and in read status.

Set Write Status

"Set write status" is externally generated. It combines with "select and ready" in AND circuit C24, and the resulting positive shift turns on the read-write-status trigger if it is off. The right output of this trigger is combined with "not file protection" in AND circuit E25 and the result is combined with "select and ready" in E18 to produce "select, ready and write." This response is returned to the control system indicating that a tape unit is selected, ready, and in write status. Whenever the output of AND circuit E25 is plus, the write inverters conduct through the write heads, and the erase head conducts.

11.4 TAPE INDICATOR 75.03

The tape indicator is a trigger that may be used to indicate certain conditions sensed within the tape unit. It may be controlled externally or internally. The trigger is turned on internally by sensing the reflective spot at the end of a reel of tape, when writing. The rear photo-cell output is AC coupled to an inverter to pull over a 20ms SS_T. The plus output of the SS_T is combined with write status in AND circuit B29, turning on the trigger. The trigger may also be turned on by bringing up "turn on TI" from the control unit if the select line is plus.

The right output of the trigger is combined again with select and becomes "select and TI on" which is sent back to the external control unit. Also, the tape indicator light is turned on. "Turn off tape indicator" is combined with select and used to turn off the tape indicator trigger if it is on. This causes the "select and TI off" line to come up to provide this indication to the external control unit.

11.5 TAPE BREAK INDICATION 75.03

If the machine is rewinding at high speed and a break occurs, provision must be made to stop the unit. This is done by using the same photo cell that is used for end-of-tape indication. A light source is brought up from underneath the tape. It shines on the cell if the tape breaks. The photo cell output is combined with the "rewind interlock status" line in 75.03 and the output is used to pick a tape break relay (R41) in 75.09.03. This is a latch pick relay that remains latched until an unload condition is initiated. To stop the reel motion, a R41-1 point opens in the circuit of R1, a run relay. When the run relays drop out, the motors stop running and the brake is applied.

Depressing the unload button picks R41LT (75.09.03) through R22-6 and R41-2. This places the machine back in normal status.

11.6 STARTING FROM LOAD POINT 75.04

To read or write at the beginning of the tape, the start line is brought up as a result of the go line from the external control. This line is sent to 75.04 and combined with "at load point" in AND circuit G20 to produce a line called "drop load point relay." This picks R19 in 75.09.03. The R19-1n/o points close to pick the latch trip coil of R42. As a result of this, "at load point" drops and "select and at load point" drops. Therefore, unless the tape is rewound, no more load point considerations are made.

11.7 START, STOP, AND REVERSE CONTROL 75.05.01

There are two ways of bringing up the start line, resulting in a start position of the moving coil. The go line, brought up externally, combined with select and ready raises the start line, and drops the stop line. Also, raising the manual start line, combined with "not arriving at load point" raises the start line. This is the combination used while rewinding and unloading.

There are two ways of bringing up the reverse line, conditioning the machine to move tape in a reverse direction. The backward line, brought up externally, combined with "select and ready" raises the reverse line.

Raising the manual reverse line raises the reverse line. This is the method used while rewinding.

11.8 READ PRE-AMPLIFIER 75.06

To read from tape, a tap is taken off the read-write head in 75.07 and tied to an amplifier circuit 75.06. As the bits are read they are amplified in the AT circuit and the output is fed to a K_{XO}. This circuit is controlled by "select, ready, and read." If the line is down (-30) the K_{XO} is biased below cut-off and the signal from the AT does not get through. However, if the line is up (+10), the signal passes through and emerges on the read-sync bus to the external circuitry. There are seven such amplifier circuits.

The component circuit diagram of the AT is on C.04.04. The input to the first stage comes from the read head, and either a plus pulse or a minus pulse represents a one bit. The input pulses should be 35 to 40mv peak to peak.

The output of the cathode follower K_{XO} should be 20 volts, peak to peak. This level should be set with the potentiometer controlling the feed back from the third stage of the AT to the first.

11.9 WRITING ON TAPE (ONLY ONE BIT POSITION CONSIDERED)

Reviewing briefly the operation of storing information on tape, remember that the tape is magnetically saturated in a predetermined direction by passing current through the read-write head in one direction. The flow of current is reversed under control of information lines entering from the control circuitry. Therefore, current is always flowing through the read-write coil in one direction or the other. The circuit for this is shown on 75.07 and C.01.07.

The right and left outputs of a write trigger are fed to an I_{WR}. The plate circuits of this I_{WR} are the two coils making up the R/W head. Because one of the two outputs of the write trigger is always up, either one side or the other of the I_{WR} is conducting, causing current to flow in the associated coil.

The write trigger is alternately turned on and off from the negative shift output of a diode gate. This diode gate is conditioned by the write bus that enters from the external control. The level of this bus represents the information to be written on the tape. The other input to the diode gate contains timed pulses that actually flip the trigger. These pulses are routed from 75.02 where they are a combination of "select, ready, and write," and write pulses generated externally. The externally generated pulses are 67 usec apart and last for 8.4 usec in most systems.

The I_{WR} is further controlled by an I_G in the cathode circuit. The I_G is allowed to conduct only when the write-status line is up. This line was generated on 75.02 as the right output of the read-write-status trigger conditioned by "not file protection." It is at plate level, so a divider is used on the input to the I_G on 75.07. When the write-status line is down (indicating read status) the I_G is cut off, preventing the I_{WR} from conducting on either side.

Remember that there are seven circuits such as the one described above, one for each of the seven channels.

11.10 WRITE ECHO

For checking purposes, a write echo pulse is developed and sent back to the external circuitry. This pulse is taken at the cathode of the I_{WR}. It is AC coupled to an I_S to feed a K_{PO} which in turn brings up the write-echo bus. The pulse is developed in the following manner.

Assume that the right side of the I_{WR} is conducting and current is flowing through one half of the read-write head. When the write triggers flip, the right side of the I_{WR} is cut off and the left side tries to conduct. However, a back EMF is developed in the half of the read-write head which was conducting. This collapsing field causes an EMF to be developed on the other half of the read-write head. The polarity of this EMF is negative at the plate of the left side. This negative polarity then prevents the left side from conducting until the EMF has been dissipated. Therefore, at the cathodes of the I_{WR}, the voltage swings downward as long as no conduction is taking place in either side of the I_{WR}. When the left side begins to conduct, the cathode voltage again rises to its original value. Thus, a negative pulse is developed and coupled to the I_S. The duration of the pulse is from 8 to 12 usec, with a nominal value of 10 usec.

11.11 WRITING A CHECK CHARACTER (LRCC)

Since the write trigger in any particular channel is turned alternately off and on to write 1 bits, the state of the trigger at the end of a block of information indicates whether an odd or even number of 1's has been written. If an odd number of 1's has been written, the write trigger is on. If an even number of 1's has been written, the write trigger is off.

If, after writing a block of information, all the write triggers are reset, only those which are on will be turned off, thereby writing a 1 on the tape. The character written as a result of resetting the write triggers is usually called the longitudinal redundancy check character. The LRCC can be used when reading this information from the tape, to indicate dropping or picking up a 1 bit in any channel.

A line usually referred to as "write check character" is routed to the machine from the external circuitry and enters 75.07 where it causes a -12 clamp and reset line to rise to ground potential. This is the Z reset for the write triggers.

11.12 ERASING

The erase head is energized through an I_{ER} on 75.07 whenever the write-status line is up, causing the complete width of the tape to be saturated in one direction.

11.13 REWIND 75.08

Rewinding may be initiated in two ways. One way is to bring up a start-rewind line externally. This is combined in 75.08 with "select and ready" to eventually form "rewind PU relay." In 75.09.03, this line picks R40 to intiate a rewind operation. When in the rewind operation, R36 is up and a line called "rewind status" is brought up (75.09.03). This line is combined in AND circuit A17 in 75.08 with "select" to form "select and rewind status." This result is sent back to the control unit to indicate the condition.

The other way to initiate a rewind operation is from the load-rewind button on the front panel. This button in 75.09.02 brings up "manual load rewind" which combines in 75.08 with "read status" to bring up "rewind PU relay." "Read status" is used because, if the unit were in write status, the read-write and erase heads would conduct and information would be destroyed as the tape was passed by these heads.

11.14 FILE PROTECTION

If a file-protection ring is placed in the groove of the file reel, the sensing pin is forced to the rear. This operates the file-protection relay armature and the AL points close. This closing causes the relay coil to be picked (75.09.06) and to hold as long as the reel is on the machine and the door is closed.

The file-protection relay BL points (75.09.01) transfer to bring up the "not file protection" line through R22-2, R31-3, R35-3. This line goes to 75.02 where it is combined with the right output of the read-write-status trigger to produce "write status." If the ring is not in the groove of the reel, the relay is not operated and "not file protection" is down. The n/cBL points cause the file-protect light to be turned on. When "not file protection" is down, writing and erasing are prevented.

11.15 FORWARD AND REVERSE SWITCH

A customer engineer's tool is provided for manually controlling the forward or reverse motion of tape. The tool consists of two push buttons that may be connected through a cord and Jones plug to the machine. The connection is shown on 75.09.01. If the forward button is pressed, R34 is energized which in turn brings up the manual-start line (75.09.02). If the reverse button is pressed, R33 is picked and the manual-reverse line is brought up (75.09.02) to reverse the forward-reverse magnet assembly. Also, R33-1 picks R34 to bring up "manual start."

11.16 MACHINE READY 75.09.03

The machine-ready line is up, and the ready light is on if R20 and R18 are picked and R36 is down. To accomplish this condition, the start key must be pressed to pick R20. The run relay R18, when picked, indicates a closed door, no blown fuses, no broken tape, DC power available and vacuum motor up to speed. R36, rewind status, when down, indicates the unit is not rewinding. The ready line must be up in order to perform such operations as read, write, backspace, or rewind from the control unit.

11.17 RESET 75.09.04

Pressing the reset key picks R30. The R30 points take the machine out of ready status and, in general, stop any tape operation that has been initiated (section 20.0).

11.18 REEL ARM LATCH

The reel-arm latch magnet (75.09.06) is energized whenever the door is open. When energized, the latch pin is driven forward to prevent the reel arm, once lifted, from falling. This is for convenience in loading and unloading the machine reel. When the door is closed, the latch magnet is de-energized, the latch pin returns under spring tension, and the reel arm falls into place.

12.0 RESUME OF LINES ENTERING AND LEAVING TAPE UNITS

The control lines entering and leaving the tape unit are pictured in Figure 15. A brief functional description of each line is given below.

Select Lines (75.01) (10 lines). The select lines are routed from external control; they determine which tape unit is to be selected.

Write Bus (75.07) (7 lines). The seven DC lines making up the write bus transmit the seven bits in parallel from the external circuitry.

Read Bus (75.06) (7 lines). The read bus consists of seven DC lines over which the seven bits are transmitted in parallel to the external control. Reading at a speed of 75 inches per second with a bit density of 200 characters per inch gives a read frequency of 67 microseconds per character.

Write Echo Bus (75.07) (7 lines). These seven lines send the image of the information as it is written back to the external control where it is used for checking purposes.

Select, Ready, and Read (75.02). This line is an output from the tape unit indicating that the unit has been selected and is ready to begin reading. The term "ready" here means that a tape is loaded into the machine and the machine is not in rewind status. This is, in reality, a response to the set-read line coming from the control system.

Select, Ready and Write (75.02). This line is also an output of the tape unit indicating that the unit has been selected and is ready to begin writing. It is a response to the set-write line coming from the control system.

Set Read (75.02). This line is an input from the control system indicating desire to read from the tape unit. It is preceded by the proper select line indication.

Set Write (75.02). This line is an output from the control system indicating desire to write in the selected tape unit.

Select and Rewind (75.08). This line is an output of the tape unit indicating it has been selected and is rewinding. Reading or writing cannot be performed if this line is up.

Select and At Load Point (75.04). This line indicates to the control system that the selected tape unit is at load point.

Select and TI On (75.03). This output from the tape unit indicates that the selected tape unit's tape indicator is on.

Select and TI Off (75.03). This output indicates that the selected unit's tape indicator is off.

Turn on TI (75.03). This line originating in the control system turns on the tape indicator in the selected tape unit.

Turn off TI (75.03). This line originating in the control system turns off the tape indicator in the selected tape unit.

Write Pulse (75.02). This is a line originating in the control system over which time pulses are sent to switch the write triggers.

Backward (75.05.01). This line also originates at the control system and controls the status of the forward-reverse magnet in the selected unit.

Start Rewind (75.08). This is a line originating at the control system which initiates rewinding.

Write Check Character (75.07). This line, originating at the control system, is used to cause the write triggers to be reset. This causes a longitudinal redundancy check character to be written on tape.

Go (75.05.01). This line controls the status of the moving coil. It originates in the control system.

13.0 SOURCES OF TROUBLE

13.1 SIGNAL DROP OUT

The nomenclature of this term indicates that the voltage amplitude of the signal was decreased to such a value that it could not be correctly interpreted by the detecting equipment as a one. In general, there are two main causes for this phenomenon.

1. An irregularity on the tape surface may physically lift the tape away from the reading head at the point where the one is being recorded on the tape. This event markedly reduces the resulting voltage amplitude obtained when reading. Surface imperfections can be caused by magnetic oxide clumps, or acetate particles.
2. The lack of magnetic coating caused by wear at the point where a pulse is supposed to be recorded is another source of signal drop out.

Dirt is one of the major causes of errors in a tape system, whether on the tape itself or on any of the surfaces which the tape travels over. The slightest lifting of the tape from the reading head, when reading a one, has a marked effect on the signal output wave form and amplitude resulting in a signal drop out.

13.2 NOISE PULSES

The difference between signal drop outs and noise is that drop outs are usually caused by the magnitude of the distance between tape and head or the magnitude of the discontinuity, while noise is generally a function of the rate of change of the movement between tape and head or the rate of change of the discontinuity. Similarly, noise errors arise from discontinuties in the magnetic coating on the tape surface. Surface irregularities also contribute to noise.

Other sources of noise or signal drop outs are metal chips that may change the reluctance of the magnetic path of the flux. Oxide clumps push the tape away from the head and also change the magnetic reluctance of the flux path.

To eliminate any errors originating from the above causes, inspect the tape drive and associated areas once per shift for any accumulations of dirt, oxide clumps, or foreign material. Set up and follow a periodic maintenance schedule. The storage of reels of tape in a hard plastic container has proven to be a great benefit in the control of dirt affecting the tape.

13.3 SKEW

In a computer system where large amounts of information are stored on tape, it is desirable to maintain such flexibility that a tape written on any tape unit can be read on any other tape unit. To attain this interchangeability, it is necessary that tape should be guided and aligned as perfectly as possible over every read-write head. This general consideration might be termed tape registration. Imperfect tape registration combined with imperfections of the head geometry (head registration) and variations of the electrical characteristics of each track give rise to the related problems of skew and tracking.

Skew is the name given to the phenomenon in which bits composing a character, though written at the same instant of time, are not read at the same instant of time.

Specifically, it is necessary to minimize skew so that the closely spaced characters on tape can be correctly interpreted and distinguished from each other. Figure 16 illustrates three of the causes of skew in an exaggerated manner. The effects of skew are magnified when the skew written into a tape by one tape drive is opposite to the skew associated with reading on another tape drive. The factors involved in the skew problem are:

1. Head skew. This is inherent in the manufacture of the head and cannot be adjusted in the field. It is derived from the fact that mechanically and magnetically the individual tracks (pole tips) are not in perfect alignment nor are they completely identical in shape.

2. Electrical skew. The wave forms produced by different tracks in conjunction with their associated circuitry, e. g. in reading identical tape signals, are not exactly alike. (See item 4 below.)

3. Angular alignment of the head and tape. This can be adjusted in the field (section 15.2.6) and is of great importance. While the average alignment is subject to adjustment, the rapid fluctuations in alignment called tape "flutter" are difficult to remove completely. The angular alignment of tape, as well as the lateral position of tape (tape tracking), is determined by the accurate location of the vacuum columns, split idlers and the read-write head (guide posts). This is explained further in section 15.2.5.

4. Signal amplitude--tracking. Two tracks have an effective skew between them if one signal is weaker than the other even though their wave forms are similar and peak at the same time. This is true because the stronger signal reaches ± 2.5 volts on the leading edge of each pulse before the weaker signal does, and this is the time that the corresponding read register trigger is set by the final amplifier. Tracking, in a strict sense, is the lateral agreement of the individual tracks of the read write head with the signal tracks on tape. This depends on the lateral position of the tape with respect to the read-write head and also the lateral position of each individual track with respect to the reference edge. The latter is held to close tolerances at the factory. Inasmuch as signal amplitude is dependent on tracking, skew is also dependent on tracking to some extent. For this reason, the pre-amps are temporarily adjusted, if necessary, to obtain 20v peak-to-peak output from the master tape when checking the skew adjustment.

5. Speed of tape. To distinguish skewed successive characters coming from tape, it is necessary to use a character gate in the control unit. The character gate is turned on by the first bit in the character, and turned off after a fixed interval such as 33.6 usec. Speed, therefore, is a factor in determining the effective skew because, when reading, the slower the tape moves the greater is the time interval between bits as a result of the geometric skew already present. Furthermore, in writing, the speed determines the distance between characters. While the average speed of the tape will probably not deviate far from the prescribed 75 inches/second (unless the belt is slipping, or there is an appreciable bind), the fluctuations of speed called "jitter" add to the skew problem. Jitter is aggravated by loose and worn parts in the moving capstan drive system.

Skew can even be observed when reading forward a tape that has just been written on the same head. This occurs with no apparent change in tape alignment and with all signal amplitudes at 20v peak-to-peak. This can be attributed to: (1) head skew, and (2) electrical skew. A probable contributing factor is that the location of the bit on tape as it is written forward is determined by the right-hand pole tip (effective), while the leading edge of the signal pulse in reading forward is determined by the

location of the left-hand pole tip (effective). Therefore, if the effective air-gap widths of two tracks are different, they will exhibit skew on their own tape. Air gap width differences are caused by difference in skim material thickness and fit of the pole pieces against the skim material.

14.0 SERVICE AIDS

14.1 FUSE REPLACEMENT

The fuses for the tape drive are located on the lower left, facing the rear of the machine. The left row of fuses are for the AC lines; the right row are for DC lines. Because a blown fuse leaves the tape drive in an unknown status, the tape drive door should be opened before a blown fuse is replaced. An open tape drive door insures that tape is not broken when the fuse is replaced, and it insures that some transient condition does not cause writing on tape as the new fuse is inserted.

14.2 ERASE HEAD POLARITY AND STOPPING DISTANCE

When in reset write status the erase head and the write heads should be magnetizing tape in the same direction. If the erase head were magnetizing tape opposite to the write heads, then the write heads would reverse the tape magnetization in seven tracks between records. This reversal of tape magnetization is undesirable.

Determine the erase head polarity as follows:

1. Write a record of all one bits with either the control unit or the tape tester. If using the tester, make sure the write triggers end up being off. (If not, keep writing short records until they do end up being off.)
2. Press the reset button on the tape drive.
3. Unload and develop the tape.
4. If the polarity of the erase head is correct, the marks on tape where the write heads were turned off are very faint. See Figure 17a. If the polarity of the erase head is wrong, the marks on tape where the write heads were turned off are very distinct. See Figure 17b.

This same method can be used to check the stopping distance of the tape. However, if the marks under the write head are too faint to be seen, the following method can be used to actually put bits on the tape.

1. Write the record of all 1 bits as before.
2. Pull the capstan motor plug and write a second record, ending with the write triggers on. If using the tape control unit, it is necessary to disable the write trigger reset line.
3. Reset the tape unit and unload.

A similar procedure can be used for determining the stopping point after backspacing.

1. Write the record of all 1 bits.
2. Backspace.
3. Pull the capstan motor plug.
4. Remove the erase inverter to prevent the possibility of destroying the beginning of the first record.
5. Write the second record, ending with the write triggers on (reset write tgr. line disabled).
6. Reset the tape unit and unload.

14.3 MOVING COIL CIRCUITRY

For satisfactory operation, the moving coil must be excited by 50ma. Refer to section 15.8.8.

Marginal conditions in the moving coil circuitry can be determined by bias checking the 140v supply to its lower limit. These conditions show up as increase in start-stop time, i.e., decrease in record gap. Primarily, the tubes in question are T01J-4, T01J-5 and T02J-4, T02J-5.

14.4 CHECKING FOR REVERSAL FAILURES

Trouble encountered while running programs involving backspacing, even though the tape drive is in correct adjustment, may be due to reversal failures. A check for reversal failures can be made as follows:

1. Write all 1 bits continuously on the tape.
2. Run a tape diagnostic that involves backspacing.
3. If the tape drive gives an error and continues to run forward when the program is stopped, it indicates a reversal failure.

The tape drive can be stopped manually. The reversing circuits and mechanism should be thoroughly investigated.

15.0 REMOVAL, ASSEMBLY AND ADJUSTMENT PROCEDURES

15.1 REMOVAL OF HEAD ASSEMBLY (P/N 333072)

With power off and machine in an unload status, remove upper and lower head covers as follows:

1. Remove read-write head cable clamp.
2. Remove read-write head plug.
3. Separate Continental Connector in back of lower main plate.
4. Remove two tension springs adjacent to jackshaft.
5. Lower upper portion of head assembly by turning jackshaft.
6. Insert 5-40, 1/2" screw with flat washer into tapped hole at upper center of head assembly to prevent the erase head from striking the read-write head.
7. Remove four screws and stop plate behind lower main plate.
8. The head assembly can now be removed as a unit by removing four screws and spacers securing it to the lower main plate. The upper two screws are removed through the holes in the upper head section.

Reassemble in reverse order. After reassembly, check adjustment of upper and lower stop blocks and head-up and head-down microswitches. Be sure to remove the 5-40 screw that has been locking the head sections.

15.2 ADJUSTMENT OF HEAD ASSEMBLY (FIGURE 18)

15.2.1 Limit Stops Adjustment

Make this adjustment as follows:

1. Remove power and operate jackshaft manually.
2. Loosen mounting screws on the erase head and position it so that it does not strike the read-write head when the limit stops are adjusted.
3. Adjust lower stop to provide 1/16" clearance between two plates at (1).
4. Adjust upper stop to stop head movement after 13 (-0, +1/2) revolutions of jackshaft.
5. Adjustable studs are provided on both upper and lower stops to adjust for clearance between stud and stop plate on the last revolution before stopping.

15.2.2 Erase Head Adjustment

Adjust the position of the erase head to provide .008" to .010" clearance between it and the read-write head, when the read-write head cover is fully down. Use a piece of IBM card stock as a gage, and adjust to the point where there is just no drag when moving the card.

15.2.3 Pressure Pad Adjustment

Adjust the position of the bracket to provide 75-100 grams tension against the tape as it is pulled through the head at (2), when the head is fully down. This tension may be measured by anchoring a gram gage to a piece of short test tape and pulling them through the head.

15.2.4 Microswitch Adjustment

The head up switch is wired n/o and should be adjusted to transfer within 1/4 revolution of the upper limit stop when head is going up. The head down switch is wired n/c and should be adjusted to transfer within 1/4 revolution of the lower limit stop when the head is going down. Slotted holes are provided in the mounting plate of each switch. Check that the switches do not interfere with the positive stops.

15.2.5 Mechanical Alignment of Head Assembly and Split Idlers

Special customer engineering tools have been provided to check the position of the read-write head assembly and split idlers with respect to the lower main plate.

A surface plate (P/N 460883) may be bolted to the lower main plate in the area just behind the upper head-cover assembly. Two threaded holes, provided in the lower main plate, are accessible only when the head cover assembly is in its uppermost position. A go/no-go gage (P/N 460884) may be fitted between the outer surface of the plate and the point to be checked.

Three points should always be equidistant from the lower main plate. These are the inner surface of the front flange of each split idler and the front tape guide post of the read-write head at the crown of the head. The go/no-go gage may be placed between each of these points and the surface plate to determine the position.

The entire head assembly (P/N 333072) should be returned to the factory if any trouble is encountered with the read-write heads or split idlers.

15.2.6 Skew Adjustment (Head Alignment)

It is preferable to make the skew adjustment using the control unit because the signal is shaped by the final amplifier and sets the read register at the critical time of the signal. More accurate syncing can be obtained from the first bit line (or the output of the read register) without so much dependence on the scope quality or adjustment. The following technique is convenient also if one desires to check the skew from any tape with bits in all tracks.

1. Mount and read the master tape. The master tape (P/N 503928) has continuous ones in the 1 and C tracks, generated with a maximum of 1-usec average skew.

2. Adjust pre-amps to give 20v peak-to-peak from 1 and C tracks, reading master tape.

3. Set the scope sync on the first bit signal in the control unit. The suggested sweep speed is 5 usec or less per cm.

4. Connect the scope input probe in turn to the output of the C track read register and the 1 track read register. The rise of the signal of the leading track should coincide with the beginning of the trace. The time difference indicated on the scale between the leading track and the lagging track is the skew.

5. Turn the adjusting screw from the front of the machine until the average signal of both tracks coincides. The average skew forward between outside tracks will

then be zero. (Turning screw clockwise causes track C to lead track 1 with tape moving forward.)

6. The fluctuations in skew (flutter) may not exceed 6 usec, otherwise tape guiding must be improved. (See sections 13.3.3, 13.3.5 and 15.2.5.)

7. After the master tape is removed, readjust the pre-amps to give 20v peak-to-peak output from tape written on the same machine.

8. With the present master tape it is possible to compare the C track output of a given character with the 1 track output of the preceding or succeeding character inadvertently, and therefore adjust for 67.2-usec skew. Consequently, if there is any doubt as to the previous head alignment, or if a new head is being installed, an interchangeability test should be run after making the skew adjustment.

As a check on the above method one may observe the read bus itself on the scope while still syncing on the first bit. The method of syncing on the read bus and observing the peaks is necessary when using the tape drive tester (section 19.4.3) but is not as accurate.

15.3 Head Wear

The entire head assembly (P/N 333072) should be returned to factory for servicing if there is irregular wear on the surface of the head and laminations sufficient to prevent intimate contact of the tape with the head. This condition causes a signal of less than 30mv, peak-to-peak across one coil of the head (on one or more tracks), when tape written with that head is read.

The head should also be replaced when there is a signal of less than 30mv, peak-to-peak across one coil of the head (on one or more tracks), because of uniform wear of the head and the laminations.

15.4 REMOVAL AND ADJUSTMENT OF TAPE CLEANER

The best procedure for removing and adjusting the tape cleaner is as follows:

1. Remove the lower head cover.
2. Extract the pin from the side of the light housing and drop out the light.
3. Remove tape cleaner.
4. Mount tape cleaner, leaving screws loose.
5. Run the head cover down as far as it will go and remove upper cover.
6. Push the tape cleaner assembly up toward the upper head cover as far as it will go. Lay the gage block (P/N 460961) between the cleaner and the read-write head. Position the cleaner so that the gage block is in the position shown in Figure 20, but never as in Figure 21. Hold the cleaner firmly while the mounting screws are tightened. Be very careful when positioning the cleaner block to prevent damage to the cleaner blade.
7. Adjust and gage the spacing between the photo-cell head assembly and the tape cleaner as shown in Figure 19. Move the photo-cell head assembly up or down to make this adjustment.
8. Tape break indicator. The reflector plate on the tape cleaner block should be adjusted so that light is directed on the photo cell (tape indicator side) to produce a maximum voltage swing from a dark to a light condition (from tape existing between

bulb and photo cell to no tape existing). This peak voltage swing is not to be less than ten volts using a 20,000-ohm/volt voltmeter. Physically adjust the reflector plate by using the adjusting screw. This screw can be secured by the setscrew to lock it into position. If more adjustment is necessary than can be obtained by the adjusting screw alone, loosen the mounting screws for the reflector plate and shift the plate itself in the oversize holes.

9. Replace head covers.

15.5 DRIVE CLUTCH ASSEMBLY

15.5.1 Removal of Drive Clutch Unit

To remove the drive clutch unit, do the following:

1. Drive the pin from the hub of each of the reels.
2. Disconnect rewind motor plug.
3. Loosen one of the two setscrews in the rewind motor rubber coupling.
4. Remove three screws holding the rewind motor bracket, being careful not to damage the motor coupling.
5. Remove the belts from the forward and reverse clutch pulleys. These belts are matched in pairs, and should be reassembled in the same order in which they are removed.
6. Remove the clamp from the cable running to the sensing arm switch.
7. Remove the Jones plug from its socket on the clutch frame.
8. Install hinges on upper main plate and be sure they are tight.
9. Remove upper head cover.
10. Remove 6 Allen head screws and plated washers from the upper main plate.
11. Carefully lower the upper main plate until it hangs from its stop chains. While doing this, remove the six spacers so that they do not fall into the machine.
12. Remove the four Allen head screws and washers holding the clutch assembly to the upper main plate.
13. Lift the clutch assembly straight up.

The small hole in each clutch surface is for manufacturing purposes. It is not an oil hole.

Reassemble in reverse order, with these points in mind:

1. The Jones plug socket on the clutch frame has no locating pin, so make sure that the plug is put back in correctly.
2. When replacing the rewind motor assembly, align the motor shaft to the reel shaft as accurately as possible.

15.5.2 Removal of the Drive Clutch Shaft Assemblies

The recommended procedure is that the entire clutch unit (six clutches) be replaced as an assembly. However, in emergencies the following procedure could be used.

1. Remove the drive clutch unit (15.5.1).
2. Mark the placement of the two rear-commutator brush-mounting bars in pencil; remove the leads from the brushes; remove the bars.
3. Loosen the Allen head screws, entering the rear of each shaft about three turns.
4. Drive the pins from the front shaft retaining collars.

5. Remove these collars.
6. Remove the screws entering the rear of the shafts.
7. Remove the rear plate, which is held by six screws and four dowels.
8. The clutch and shaft assemblies may now be removed from the frame. Note carefully the position of any shims; do not interchange the two assemblies.

Assemble in reverse order. After assembly, check the brushes for good tension and square contact.

15.5.3 Adjustments on Drive Clutch Unit

The commutator brushes are positioned to make contact squarely and in the center of the commutator rings. Loosen brush mounting screws to do this. Form tension strap for a strong wipe to insure no arcing at the brushes. Excessive carbon deposits have been found on the commutator rings. They produce contact resistance affecting the operation appreciably and, therefore, should be removed.

The take-up spindle block is positioned vertically with the mounting screws in elongated holes to bring the chain gear level with the chain gear on the left stop-clutch drive-shaft. Position the stop-clutch drive-shaft bearing blocks so that the worm teeth are fully meshed with the teeth on the stop-clutch gears and the shafts are free from binds. The forward and reverse motors are positioned vertically to provide normal V belt tension--about one inch free play at the center of the longest belt span.

15.6 VACUUM UNIT

15.6.1 Removal and Adjustment of the Vacuum Columns (Figure 22)

Two methods are used to fasten the vacuum columns to the lower main plate. On earlier machines, two mounting screws are used per column; on current machines, four mounting screws are used. The removal and adjustment of both types is explained.

The right column can be removed in the following manner. Remove the lower clean-out cover, the lucite cover angle clamps and the lucite cover. Remove the four screws (from rear) holding the lower end of the column to the manifold. Remove the screws securing the column to the lower main plate. Remove the column, being careful not to damage the flutter valve operating arm. Reassemble in reverse order, making sure the neoprene tubes to the vacuum column switches are in place.

When necessary to remove the left vacuum column, it is quicker to remove both columns and the manifold as an assembly, and then remove the left column. To do this, disconnect the vacuum hose from the manifold and the leads from the flapper valve microswitches. Loosen the two screws holding the manifold to the machine base. Remove the lower clean-out covers, the lucite cover angle clamps, the lucite covers, and the screws securing both columns to the lower main plate.

When reassembling the lucite covers, make sure they are tight against the vacuum chamber covers (C) and the lower clean-out covers to prevent air leakage. Be very careful when handling the angle clamps and the vacuum columns because they are manufactured with a very close tolerance on straightness. Do not tighten the holding

screws for the angle clamps too tightly, as they can distort the shape of the clamps and lucite.

The columns are adjusted to be parallel to the lower main plate. On earlier machines (two holding screws to the lower main plate), adjust as follows: remove the lucite cover angle clamps and loosen the two manifold mounting screws at the base; position the columns so that dimensions (A) and (B) are within .005" of each other.

On the later machines (with four holding screws to the lower main plate), the above adjustment is set at the factory. Be sure not to bend the lower portion of the columns when tightening the manifold to the base.

Adjustment of the columns with respect to the lower main plate is not impaired by the removal of the angle clamps and lucite cover for cleaning purposes.

15.6.2 Adjustment of Vacuum Safety Switch

With power on the vacuum motor and tape in columns, turn the adjusting screw clockwise until the switch transfers, stopping the drive motors. Back off on the adjusting screw until the switch again transfers, and continue backing one turn farther.

When the vacuum is turned on without tape in columns, the vacuum safety switch should not transfer from its depressed position until both flapper switches have transferred to their rear positions. Change the above adjustment if necessary.

15.6.3 Adjustment of Flapper Valve Switches

Adjust right and left flapper valve switches so that they are depressed and make with at least 1/16" overtravel at the actuating roller when vacuum is on and tape is removed from the column being adjusted. The switch should release and break when the minimum amount of tape required to seal that column is inserted. Any leakage in the vacuum columns seriously affects correct operation of the flapper valves.

15.6.4 Adjustment of Vacuum Column Switches (Figure 11)

Loosen the adjusting nuts and form the upper contact straps to provide 1/64" rise of strap from support at (1) when the center strap is at rest. Adjust lower support for .020" (+ .010", -.000") gap between lower points at (2). Adjust nuts to provide 1/64" clearance at (3) when diaphragm is at rest. Be sure nuts are free on threads of push rod to prevent damage to diaphragm when adjusting.

The lower contacts should have 3/64" travel after making if push rod is depressed until diaphragm bottoms. Both normally closed points should break before either normal operating point makes and vice versa. A careful reforming of contact straps in addition to adjusting nuts is permissible to obtain these results.

15.6.5 Removal of Vacuum Pump

Remove the vacuum pump as follows:

1. Loosen clamp on vacuum hose at manifold. Pull hose from manifold pipe.
2. Separate vacuum motor plug.

3. Unscrew the four bolts that mount the pump. Lower the pump out to the right of the machine. Be careful that the pump inlet pipe does not strike the floor of the machine, possibly jamming the impeller blades.

15.6.6 Vacuum Column Tape Guide

The guide fits in each vacuum column and bears on the tape just before the tape reaches the moving pulley. Any tape twist in the vacuum columns is taken out before the tape reaches the idlers and head assembly.

The following adjustment to the tape guides should be made with vacuum on and tape in the columns: Move the block away from the column side 1/64" to 1/32" farther than necessary to make contact across the full width of the tape. Make sure that the guide is not placed in a position where the tape will be against the drive capstans when in stop status.

15.7 DRIVE CAPSTAN MECHANISM

15.7.1 Removal of a Drive Capstan

Remove the capstan belt and remove the elastic stop nut from the rear of the capstan shaft while holding the shaft from turning by a pin punch inserted into the hole in the capstan pulley. The drive capstan and shaft may be pulled out from the front of the machine. Carefully prevent the pin punch from striking the capstan retracting slide assembly. The needle bearings are held in a race so that there is no danger of their falling out.

15.7.2 Removal of a Capstan Housing

Remove the capstan drive belt. On the retracting operating shaft, loosen the fork operating arms and the inboard clamps; remove the clip holding the operating link to the solenoid plunger link.

If the left housing is to be removed, move the shaft far enough to the right to clear the housing. If the right housing is to be removed, move the shaft to the right until it clears the left housing, disconnect the solenoid plunger, and remove the housing with the shaft in it. The housing is held to the lower main plate by four Allen head screws accessible at the front. To remove the one behind the vacuum column, use an abbreviated Allen wrench. (One should be sawed or ground off for this purpose.) Remove these screws and pull the housing from the rear.

When assembling, position the housing so that the operating shaft is free from binds. Make and check all shaft adjustments.

15.7.3 Capstan Retracting Mechanism

The retracting solenoid assembly may be removed by unlatching the plunger, then removing the leads to the coil and latch magnet armature and the three mounting screws. The solenoid plunger is removed by removing the screw through it which holds the two links. The dashpot may now be worked up and out to the left of the machine.

15.7.4 Capstan Retracting Mechanism Adjustments (Figure 13)

The horizontal operating shaft should be free of binds. Accomplish this by shifting the position of housings. The solenoid plunger and linkage should be free of binds. Shift components under the mounting screws.

The pin of the solenoid latch assembly should be as close as possible to the top of the solenoid without restricting the sliding freedom of the latch pin. Adjust by moving the assembly anchored by screws at (1). Wind the torsion spring 1/2 turn clockwise and hold it with a clamp at the end of the shaft.

Maintain 1/16" clearance between operating arm and dashpot arm at the top of the operating arm. Inboard clamps should position the shaft for minimum axial movement without binds. With capstans all the way out, push a fork forward and adjust the arm clamp to provide .016" ± .005" gap between the arm and fork at (4). Adjust both sides.

With solenoid plunger latched down, there should be at least perceptible clearance between tape pin and hub of operating link shown at (2) in insert. The solenoid may be shifted downward to obtain this clearance. Make a final check to insure that both capstans are under tension when extended.

The capstans-in microswitch operating cam (5) should be adjusted to operate the switch slightly before capstans reach a fully retracted position. The capstans-in microswitch must remain operated after the solenoid is latched down. Adjust the operating cam at (6) to operate switches slightly before the capstans reach the forward position. To eliminate operation at more than one point, shift the microswitch on its mounting screw.

The solenoid-latch armature backstop screw is adjusted to obtain .060" between armature and backstop (7).

15.7.5 Drive Belt Tension (Figure 23)

Adjust the screw at (1) to provide tension on pulley system requiring about four lbs. force at (2) to distort belt as shown. Measure this with the push-pull scale (P/N 9900012).

15.8 MOVING COIL UNIT

15.8.1 Removal of the Moving Coil

Remove the moving coil in the following manner:

1. Remove the moving coil leads from the terminal block.
2. Unscrew the terminal block from the magnet frame.
3. Lift the lucite coil cover back and off.
4. Loosen the setscrew in the guide block and turn this block counterclockwise out of the way.
5. Free the horizontal link by removing the clips connecting the aluminum links and the clip connecting the forward-reverse magnet armature.
6. Carefully work the moving coil and link assembly up and out. The cavity in which the moving coil is suspended should be cleaned of all foreign matter before

replacing the coil. This cleaning may be done with a piece of IBM card covered with Scotch Electrical tape, adhesive-side out.

7. The complete magnet assembly may be positioned on the lower front plate so that the moving coil does not bind in the cavity. Position it by shifting it in the oversize holes.

CAUTION: Never remove or loosen any screws in the magnet assembly; doing so would greatly reduce the gap flux density.

15.8.2 Removal of Moving Pulley

Remove the retaining wire from its position around the moving-pulley fork and pull it out of the hole in the moving-pulley pivot shaft. The shaft may then be removed and the pulley removed from the fork. Replace in reverse order.

15.8.3 Removal of Moving Pulley Fork Assembly

Remove the pulley as described above. Using a good solid backing to prevent bending the shaft, drive the two taper pins out of the fork hub. Carefully remove the spring clip from the moving coil link at the rear of the fork assembly. The fork shaft may then be removed from the rear.

Replace in reverse order, taking care that the moving coil linkage is not bent when the spring clip is replaced.

15.8.4 Moving Coil, Forward-Reverse Magnet, Stop-Capstan Adjustments

The purpose of the following adjustment procedure is to keep the entire motion control linkage as symmetrical as possible, in both a forward and reverse status. The start-stop times in either direction should be as nearly equal as the tolerances of the system will allow. The adjustments must be made in the following order to insure required results. The first adjustments are made with power off and the tape unit unloaded.

Positioning the moving coil:

1. Turn the left and right stop capstans so that the low radius is down.
2. Hold both the forward and reverse moving pulleys up in contact with the low radius of the stop capstans by pulling down on the moving coil pull rod. Position the moving coil on the pull rod, by loosening the nut and turning the moving coil on the pull rod, so that the coil does not bottom on the magnet. At this point, check to insure that the magnet assembly is positioned correctly to prevent the pull rod from striking the core. Check also that the moving coil and its linkages do not bind at any point in the up-and-down or sideways motion of the moving coil system. Neither the guide at the top of the pull rod nor the forward-reverse magnet armature should interfere with any motion of the system.

Positioning and adjusting the forward-reverse magnet (Figure 7):

1. Remove the forward-reverse magnet assembly from the machine. Do this by removing the link from the stud of the forward-reverse magnet armature and then removing the holding screws (8), through the lower main plate.
2. Loosen the six lock nuts at (2) and (3) and (9) to give complete freedom to the armature and magnet coil yoke assemblies.

3. Check for binds or rust at armature pivot.

4. Loosen the yoke holding screws (7) and squeeze forward and reverse magnet yokes together, until the armature is held firmly between them. This positions the magnet yokes and armature for proper sealing of the armature when final adjustments are made. Tighten the yoke holding screws at (7) with the assembly squeezed together. Tighten lock nuts at (9).

5. Align the armature with the center line of the pivot point and the brass mounting bracket, and hold in this position by running the lock nuts (3) up finger tight. Check that all screws in the assembly are tight before replacing. Extend the capstans by hand.

6. Replace the magnet assembly in the machine, being careful not to bend the linkages. The holding screws (8) should be left loose until the assembly is positioned, so that the armature stud meets its arm when holding the moving pulleys down against the drive capstans. Tighten the holding screws (8) with the assembly in a vertical position. Make sure that the assembly does not rock or shift when it is tightened. If it does, change the adjustment (5) slightly, or check whether the back surface of the assembly is rounded. This establishes a good starting point for positioning the forward-reverse magnet assembly.

7. Loosen the lock nuts at (3) and back the forward and reverse magnets off the armature about 1/16" to establish a starting point for the final adjustment of the armature travel.

8. Turn on power and load the tape drive in a normal manner. Disconnect the motor plugs to stop the drive capstans and the reel drive motors.

9. Put the machine in a reverse-go status to attract the reverse magnet armature and move the moving coil up. Adjust the lock nuts at (2) (3) on the reverse magnet side to obtain .020" ± .001" clearance from the forward or right moving pulley to the drive capstan (4). Do this with the tape in the machine so that the vacuum holds the moving pulley in its normal operating position.

10. Put the machine in a forward-go status and adjust the lock nuts (2) (3) on the forward magnet side to obtain .020" ± .001" clearance from the reverse or left moving pulley to the drive capstan (5). Tighten both lock nuts at (3). Make sure the armature seals properly without binding on the bottom of the yoke or the pivot when all the lock nuts are tight. This should make the armature equidistant from both magnet yokes when the forward-reverse magnets are de-energized and the moving coil is in the start position. If this result is not possible, further positioning of the forward-reverse magnet assembly on the mounting plate allows this condition to be achieved. Centering the magnet assures that the linkage is moved an equal distance to either the forward or reverse side, making the start stop timings the same in both the forward and reverse direction.

Adjusting start-stop:

1. With the tape still loaded in columns, and motor plugs disconnected, reset the machine.

2. Remove R34 from tape drive to cripple the manual go circuit. The machine should be in a forward stop status.

3. With the machine in a forward stop status, rotate the left stop capstan in a clockwise direction to obtain .008" between the right moving pulley (4) Figure 7 and the forward drive capstan.

4. Set reverse-stop status by using the manual reverse switch on the tape drive tester or the customer engineer control box. Rotate the right stop capstan in a counterclockwise direction to obtain .008" between the left moving pulley and the reverse drive capstan (5) (Figure 7).

At this time, with the forward-reverse magnet de-energized, the forward-reverse armature should be centered, whether the moving coil is in a start or a stop status.

5. The final start-stop adjustment is checked by the use of the scope and should be set at 4.5 ms to 5.5 ms (Figures 24, 25). The start-stop times must be checked in both directions with the scope. A minor adjustment of the start-stop times, by changing the position of the stop capstans in the proper direction, is the proper procedure to obtain optimum operation. The .008" in steps (3, 4) should be checked after any change in the stop capstan setting and should not be changed more than .003" to obtain the proper timings. (Check that the non-driving moving pulley does not strike the drive capstans. Do this by inserting a .005" feeler gage between the moving pulley and the drive capstans on the non-driving side. No drag should be felt. Check in both directions.) When these times are not within limits with the above adjustments, the condition indicates some trouble from a binding or worn linkage, an error in making the recommended adjustments, or tube trouble in either the moving coil driving circuits or the forward-reverse magnet inverters. Refer to section 19 for operation of the tape tester.

15.8.5 Tests for Moving Coil, Forward-Reverse Magnet, and Stop-Capstan Adjustments

The following tests may be made to check adjustments:

1. With the above adjustments made, the capstan motor running, and no tape between pulleys, the moving pulley (which is not being driven) should not strike its drive capstan as the pulley moves from a stop position to a neutral position.

2. Check in the forward condition by moving the motion control switch from stop to forward several times. The moving pulley on the left (facing the machine) should not rotate appreciably. If the moving pulley rotates, it is likely that it is striking the drive capstan. The pulley sometimes rotates because of its inertia, without having interfered with the capstan. To verify this possibility, remove the capstan motor plug and repeat the above test. If there is still the same amount of rotation, there is no interference.

To check in the reverse condition, interchange the edge connectors 1n and 1p and move the motion control switch from stop to reverse several times. The moving pulley on the right should not rotate appreciably.

The malfunction of both moving pulleys' driving at once may be observed by another procedure as follows:

Load a tape with all ones written in one channel into the machine and observe the output of the read-write head in that channel. The signal envelope should rise to a fairly steady value if conditions are normal. However, if the moving pulley on the non-driving side is striking its drive capstan the tape will tend to stop momentarily. This stopping causes the signal envelope observed to drop sharply or even reverse and then return to normal (Figure 24).

15.8.6 Start and Stop Time

The following procedure may be used to check start and stop time of the tape unit:

1. Use a reel of tape with ones written continuously on the center track.

2. Start and stop the tape unit by using the customer engineer manual control box without the tape unit's being selected, or by using the tape drive tester.

3. The "start envelope" should be similar to Figure 24. After calibrating the scope sweep circuit, use a positive external trigger input from 03J-P2. Obtain an input signal of 20 volts (peak to peak) from Fn. See section 19.4.2. Variations from this envelope can be caused by gap adjustments, the moving-coil wave form, or moving pulley interference, as shown in Figure 24.

4. The "stop envelope" should be similar to Figure 25. Use a negative external trigger input from 03J-P2. Obtain an input signal of 20 volts (peak to peak) from Fn. Variations from this envelope can be caused by gap adjustments, the moving-coil wave form or moving pulley. See section 19.4.2.

15.8.7 Reverse Magnet Transfer

Forward to Backward Status. With the tape unit not selected and in stop status, use a positive trigger input from 02J-P1. Obtain an input signal with probe on 02J-P6. The magnet may be transferred from the backward to the forward status by using the switch provided on the customer engineer control box or by using the tape drive tester. The magnet-coil voltage wave form then should compare with Figure 26. Variations from this wave can be caused by improper gap adjustments, seating of armature, or coil current, as shown in Figure 24. See section 19.4.4.

Backward to Forward Status. This status is the same as above except that the positive trigger input is from 01J-P1 and the input signal is obtained with probe on 01J-P6. See section 19.4.4.

15.8.8 Moving-Coil Wave Form

The tape unit need not be selected for this check. The moving-coil wave form should compare with Figure 27, when the scope is connected across the 10-ohm resistor at connectors 1r and 2n using internal sync, five ms per major division, and .5v per major scale division sensitivity. CAUTION: HIGH VOLTAGE. The scope frame is about 100 volts above ground with the above connections.

Change the polarity on internal sync to get a stop pulse and a start pulse both of which are the same as in Figure 27. See section 19.4.5.

15.8.9 Systems Checking the Inter-Record Space

With mechanical adjustments, start and stop envelopes and times, and start delay in the control unit properly adjusted; with the tape unit selected, check the inter-record time with scope by reading records written on same machine. Obtain signal input from a read bus using external sync from an appropriate end-of-record pulse. The time between records should be 10 ms (+2 ms, -0 ms). The inter-record space measured on this tape when developed should be 3/4" ± 1/16". The effect of start and stop time on inter-record space is shown in Figures 24 and 25.

15.9 MISCELLANEOUS ADJUSTMENTS

15.9.1 Machine Reel Sensing Arm

Adjust contact operating screw so that points make contact when about 1/2" of tape is on the reel.

15.9.2 Machine Reel Brake

Adjust the machine reel brake with the potentiometer so that the reel is stopped when about 1/16" of tape is on the reel after rewinding from a full reel of tape with the machine-reel sensing-arm switch adjusted as indicated above.

15.9.3 Time Delay

Adjust time delay so that it runs for about 1-1/2 seconds after the machine reel has stopped after a high-speed rewind.

15.9.4 Magnetic Clutch Adjustable Resistors

Adjust resistors in the resistor box so there are 30 $\pm$ 5 volts across each clutch when it is energized through vacuum switches.

15.9.5 Adjustment of Photo Cell Output

The photo light sources are adjusted with the 1k-ohm potentiometer across R14. This potentiometer is located on the rear of the relay gate. Adjust the potentiometer until the total voltage across the two bulbs in the photo cell assembly is 2.5v (+0 -.2v) when unloaded. The voltage across any one bulb should not exceed 1.5 volts. Replace the photo cell if it does not conform to the following:

1. Dark resistance 600 K to 2.4 M ohms.
2. With the light source adjusted as above, the DC change in level of the photo cell output (from tape under the photo cell to reflective spot under the photo cell) must not be less than 10 volts. Measure between ground and the white lead on each photo cell.

NOTE: One of the pins on the photo cells may be quite rough on the end. Do not file these pins. The cells are evacuated through them and filing may destroy the seal. Do not solder photo cell terminals without removing the photo cell.

15.9.6 File Protection Device

Adjust this device by loosening the relay mounting screws and moving the relay on its bracket so that a reel with an insert depresses the plunger sufficiently for the A points to make with at least .005" overtravel. With the relay energized, there should be at least .060" gap between the plunger and the file protection ring, and B point should make with at least .005" overtravel.

15.9.7 Tape Break Light Testing

The tape break light and circuit may be checked in the following manner:

1. Unload the unit and remove the reels. Tighten the reel holding nuts.
2. Place a piece of card across the read-write head and tape cleaner.
3. Hold the reel arm up.
4. Press the load-rewind button.
5. After the file reel hub gets up to speed, remove the piece of card. The file reel hub should stop immediately.

NOTE: When removing the tape break light bulb, care must be taken to return the special washer which is located between the bulb and its socket. The bulb will not remain in place within the assembly without the washer.

15.9.8 Write Current Measurement

The write current should be indicated by a reading of 56v ± 5v measured across the 5.1k-ohm resistor at test points A4 and A8 of each track. This is the cathode resistor of the I_{WR}.

15.9.9 Read Circuits

When observing normal tape read signals, look for a sufficient gain to be available to obtain 22v peak to peak at the read bus. The gain potentiometers should then be set for 20v peak to peak at the read bus observed on an oscilloscope. Use a reel of tape of known quality. Write 1's in all tracks, and then read this same tape when setting the gain potentiometers.

There is no master tape for comparing the amplitude of all tape drives to a standard. The limits of the tape drives are broad enough to handle any normal variations of signal amplitude of tapes written on one machine and read on a different machine.

15.9.10 Reel-Hub Shimming Adjustment

When the reel-hub knob is turned in a clockwise direction from the front of the machine, the steel cover over the reel is forced to the rear and the diameter of the rubber ring is expanded about the circumference of the reel. When the ring is expanded sufficiently, removal of the reel is prevented. However, if the rubber ring is allowed to expand too much there is a possibility of placing a permanent bow in the steel cover. Also, damage may result to the reel and rubber ring.

Shims (P/N 1091333) are placed between the knob and the hub assembly to prevent too much tightening of the knob.

Take the following steps when shimming the assembly:

1. Assemble a minimum of 24 shims.
2. Place the gage (P/N 460798) over hub.
3. Remove one shim and tighten knob.
4. Attempt to remove the gage by grasping it firmly with two hands and applying a steady force parallel to the axis of the shaft.
5. Continue to remove one shim at a time until the gage cannot be removed.
6. Add one shim at a time until the gage can be removed easily.
7. Note the number of shims at completion of step 6 and subtract four to obtain the quantity of shims required.

16.0 LUBRICATION SPECIFICATIONS

IBM 24

Take-up motor worm drive. (Lubricate as required.)

IBM 9

Capstan and take-up motors (Lubricate every 12 months.)
Tube gate blower motors. (Lubricate every three months.)
Capstan shaft needle bearings. (Inspect periodically, and use two or three drops of IBM 9.

IBM 6

All pivot points in tape drive linkage.
Inspect oilite bearings in capstans housings and moving pulley periodically for wear or gum accumulation. Replace or clean as necessary.
Split idlers and rewind idlers, moving pulleys and bushings. (Lubricate sparingly.)
Dashpot cylinder. (Use light films of IBM 6.)
Capstan belt idler pulley. (Lubricate as required.)
File protection plunger. (Lubricate very sparingly.)
Head guides and jackshaft. (Lubricate sparingly.)
Retracting linkage. (Lubricate as required.)
Forward-reverse armature pivots.

17.0 PREVENTIVE MAINTENANCE

The head assembly including the pressure pad, magnetic recording head surface, tape break cleaner block, split and guide pulleys, and top of the vacuum columns, should be cleaned at the beginning of each assigned period of customer operation in anticipation of eight hours' usage. The pressure pad can be cleaned best with an IBM typewriter brush (P/N 1018992). The other surface may be cleaned with a lint-free cloth or cotton tipped stick dampened with a suitable solvent. The vacuum columns should be disassembled to clean the walls every 40 hours of operation. A cloth with solvent also does a good job in this operation.

Follow this cleaning schedule strictly to attain maximum tape reliability:

1. Reliability (daily). Establish reliability by use of a suitable program.
2. Reliability (monthly). Establish reliability monthly by obtaining 15 minutes of error-free operation with a suitable program.
3. Abnormal DC-- voltage tests (monthly). Vary the following voltages and obtain one minute of error-free operation at each limit while operating a suitable program.

Nominal Voltage	Recommended Test Limits
-60	-54
	-78
-130	-117
	-137
+140	+133
	+150

NOTE: In case of random tape errors that are not revealed in above tests, try varying voltages in the central processing unit while operating a suitable program.

4. Tape drive mechanism (every shift). At the beginning of each shift of customer operation, clean the following: tape head, drive capstans, stop capstans, split idlers, and moving pulleys, pressure pad and vacuum-column metal tops.
5. Skew test (quarterly). Check for skew using a master tape (P/N 503928) with either a control unit or a tape drive tester.
6. Interchangeability test (quarterly). Using a suitable program, write 500 feet of tape on one unit. and check on three other units if possible. In case of trouble, check for skew, tracking, pressure pad and mechanical adjustments.
7. Amplifier alignment (monthly). Check the pre-amplifiers for proper adjustment. (Any time a tube is replaced, the amplifier should, of course, be re-aligned.) Check range, pulse width.
8. Special pulses and timings (monthly). Use an oscilloscope to check the following pulses:

Start envelope	End-of-file OR
Stop envelope	Tape break single shot
Write pulse	Moving coil current
Echo pulse	Erase coil current
Load point single shot	

9. Vibration test (monthly). Vibration check the tube panel while operating the unit.

10. Lamps (monthly). Check functional operation of lamps. Refer to EDPM CEM 86 for proper resistance values.

11. Tape drive maintenance with tape tester (one unit per shift). Follow this check list as closely as possible when removing a tape unit from the system. For additional information, see CEM 180.

11a. Check start-stop time (forward, backward).

11b. Check high-speed rewind (including total rewind time, starting at critical point, creeping of machine reel, and tape break circuitry).

11c. Clean the column, head, capstans, idlers, and so on.

11d. Check the vacuum columns (including the bellow switch, column switches, and flapper valve switch.

12. Tape drive maintenance with tape tester (monthly). Check the forward-reverse magnet transfer time, the friction drive clutch (being sure it is clean), and the air filters. In addition, perform any other tests scheduled on a monthly basis, which may be performed suitably with the tape unit removed from the system.

18.0 TYPE 727 RELAY WIRING DIAGRAM

The following diagram is a partial duplication of the tape drive unit systems diagram. It should be used as an aid in learning, not in servicing, the machine. For simplicity, the wiring is not shown point to point.

A convenient fan-fold diagram can be made by taping the pages together.

DUO RELAYS

NO.	COIL	POINTS			
		AU	AL	BU	BL
1	A		H		D
2	C	D	D	G	C
3	C	H	A	H	G
4	D				
5	D	E	D		F
6	D	G	B	E	E
7	G	E	D	K	F
8	F	G	D	E	E
9	G	F	A	F	E
10	G	F	A	F	E
11	D	F	A	H	G
12	F			E	
13	H				
14	H		A	C	
FP	B				J

WIRE CONTACT RELAYS

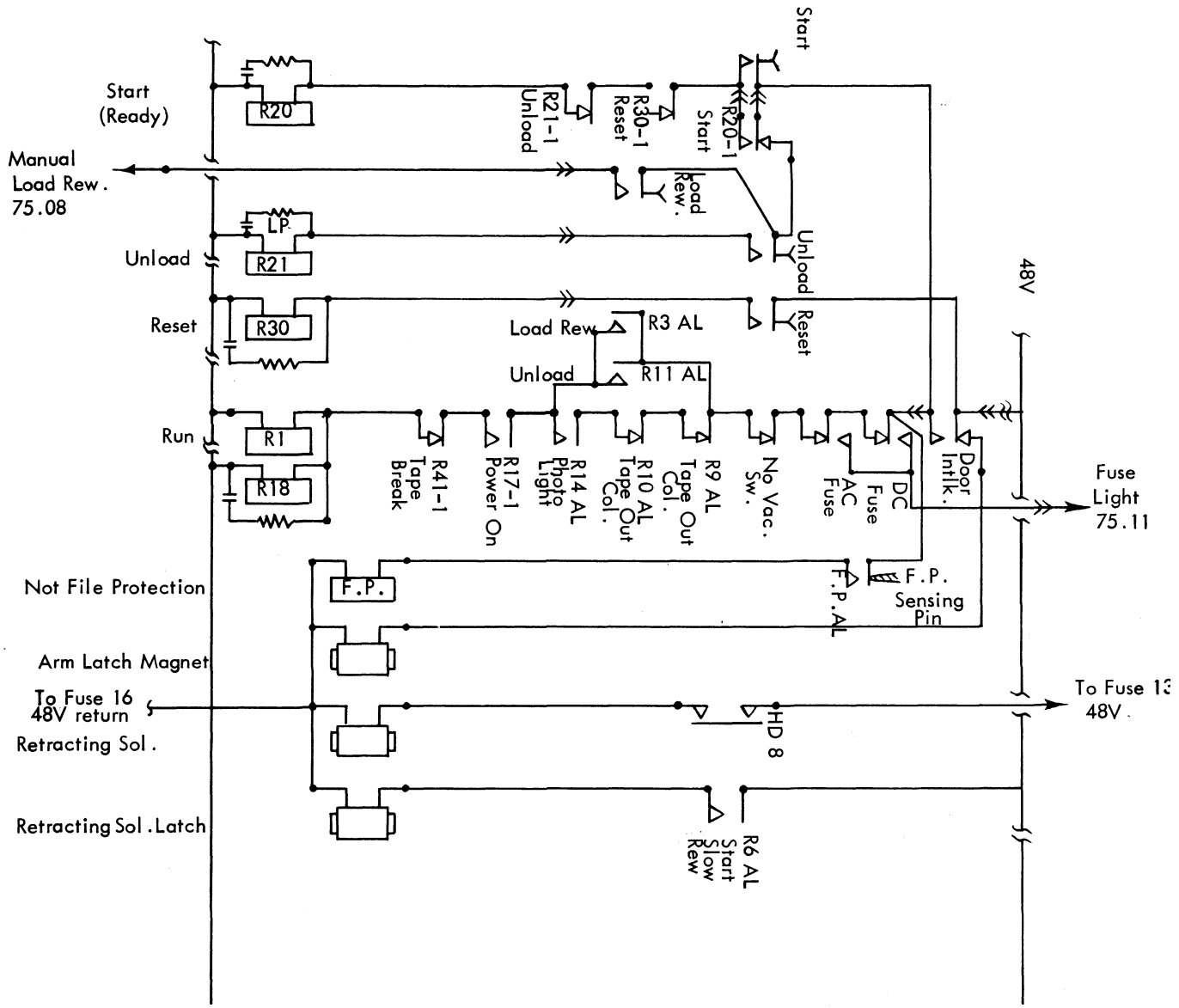
NO.	COIL	POINTS							
		1	2	3	4	5	6	7	8
17	C	A		J	H				
18	B		I	K	K				
19	L	K							
20	A	A	K	J	K				
21	ApCt	A	D	C	D				
22	D	H	J	E	J	J	K	D	H
26	FpCt	H	E	C					
30	A	A	D		I				
31	C		I	J	I		E		
33	I	I	J						
34	I	E							
35	I	I	I	J	H				
36	I	K		J	K				
40	L	C							
41	LpKt	A	K	G					
42	LpKt	I	K	L					

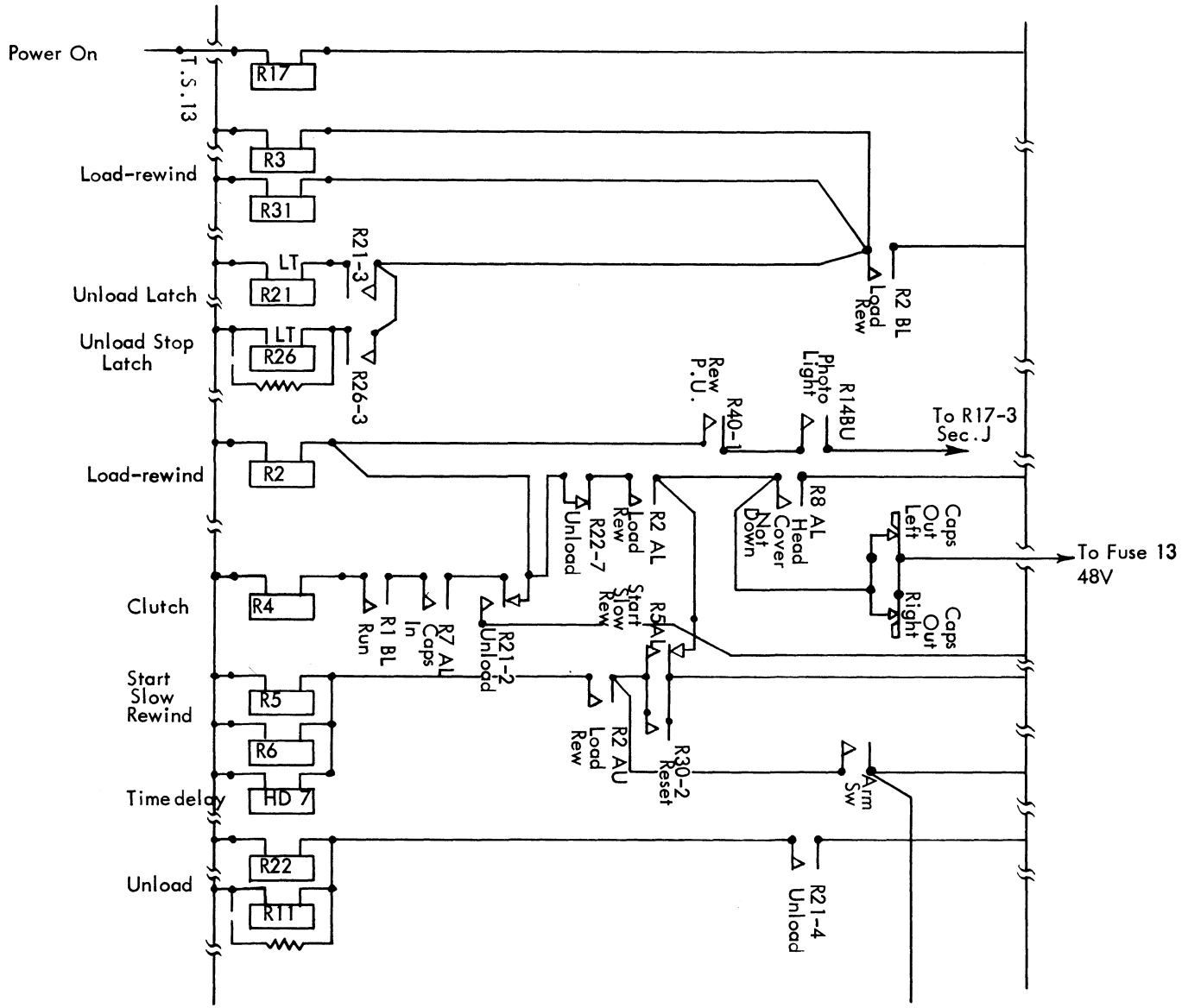
Relay	PICK	POINTS
HD 1	H	
HD 2	H	
HD 3	H	
HD 4	H	
HD 6	E	
HD 7	D	
HD 8	G	B
DP 1	E	
DP 2	H	
DP 3	F	

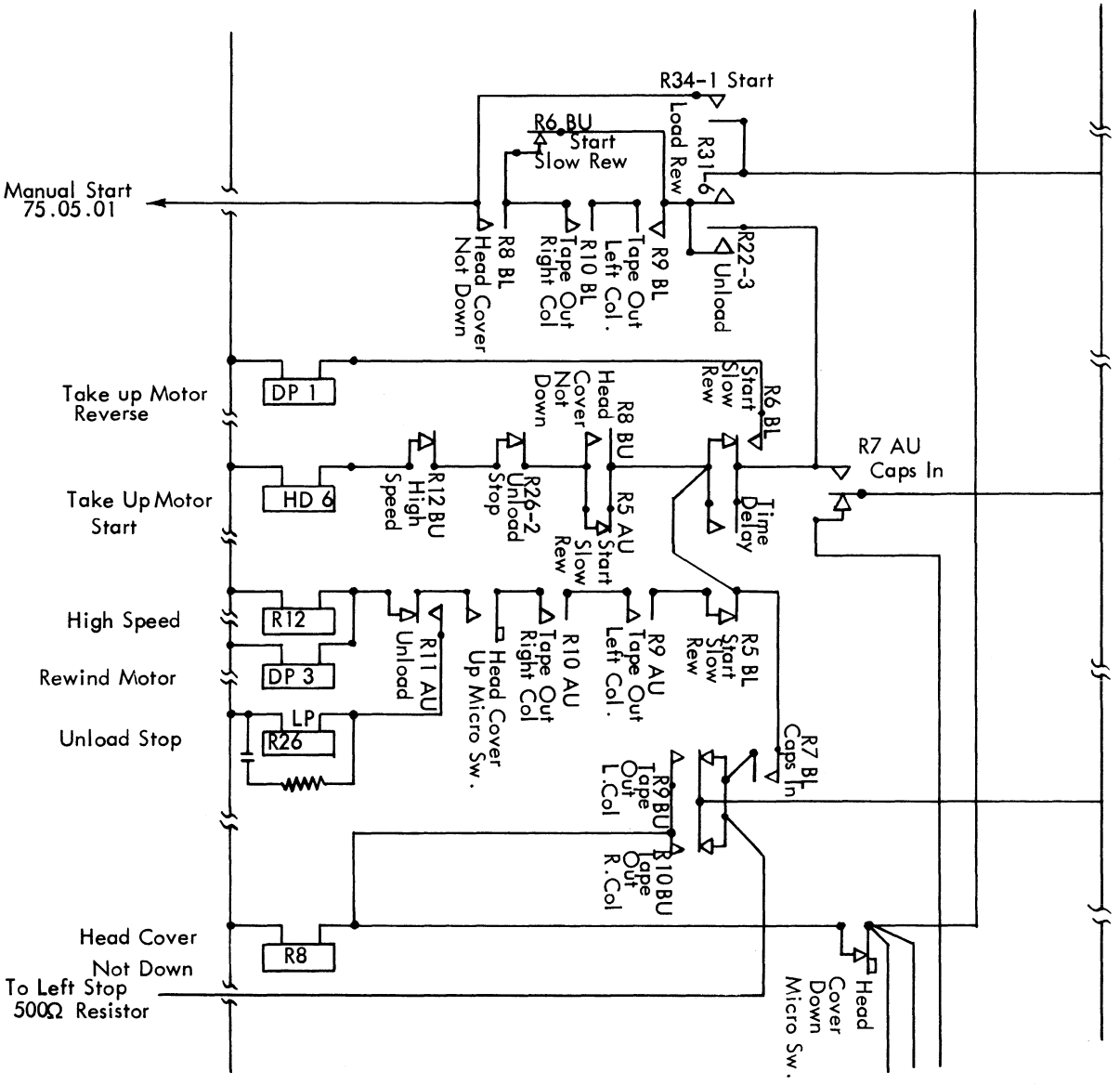
MISCELLANEOUS

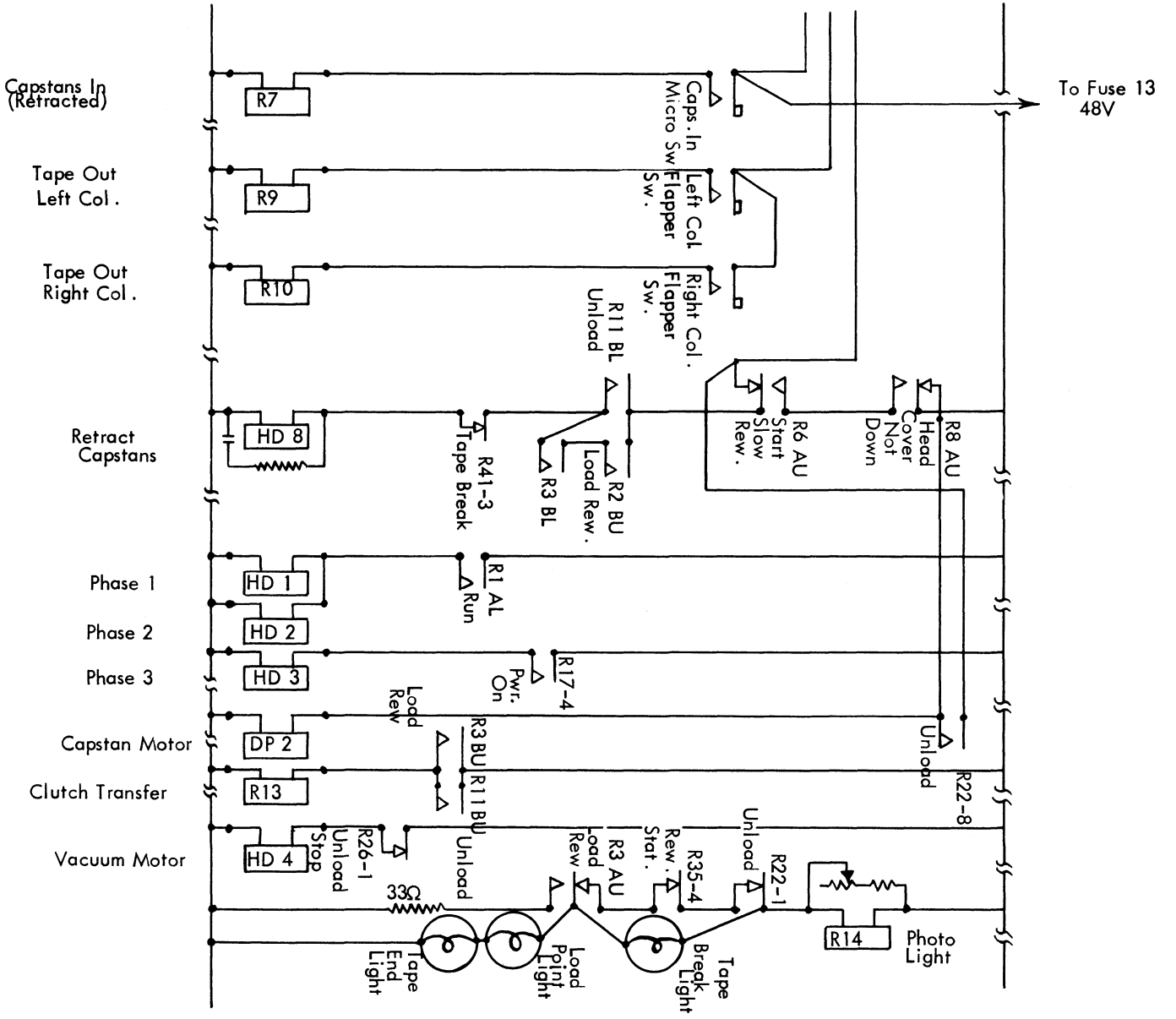
AC-DC Fuse Micro-switch	A
Capstans in micro-switch	G
Capstans out micro-switch	D
Door interlock	A
F.P. sensing pin	B
Fwd-Rev. manual push button	!
Head cover down micro-switch	F
Head cover up micro-switch	F
Column flapper micro-switch	G
Time delay point	E
Load-rewind Key	A
Unload key	A
Start key	A
Reset key	A
No vacuum micro-switch	A
Reel arm contact	D
Reel arm latch sol.	B
Retracting sol.	B
Retract sol. latch	B

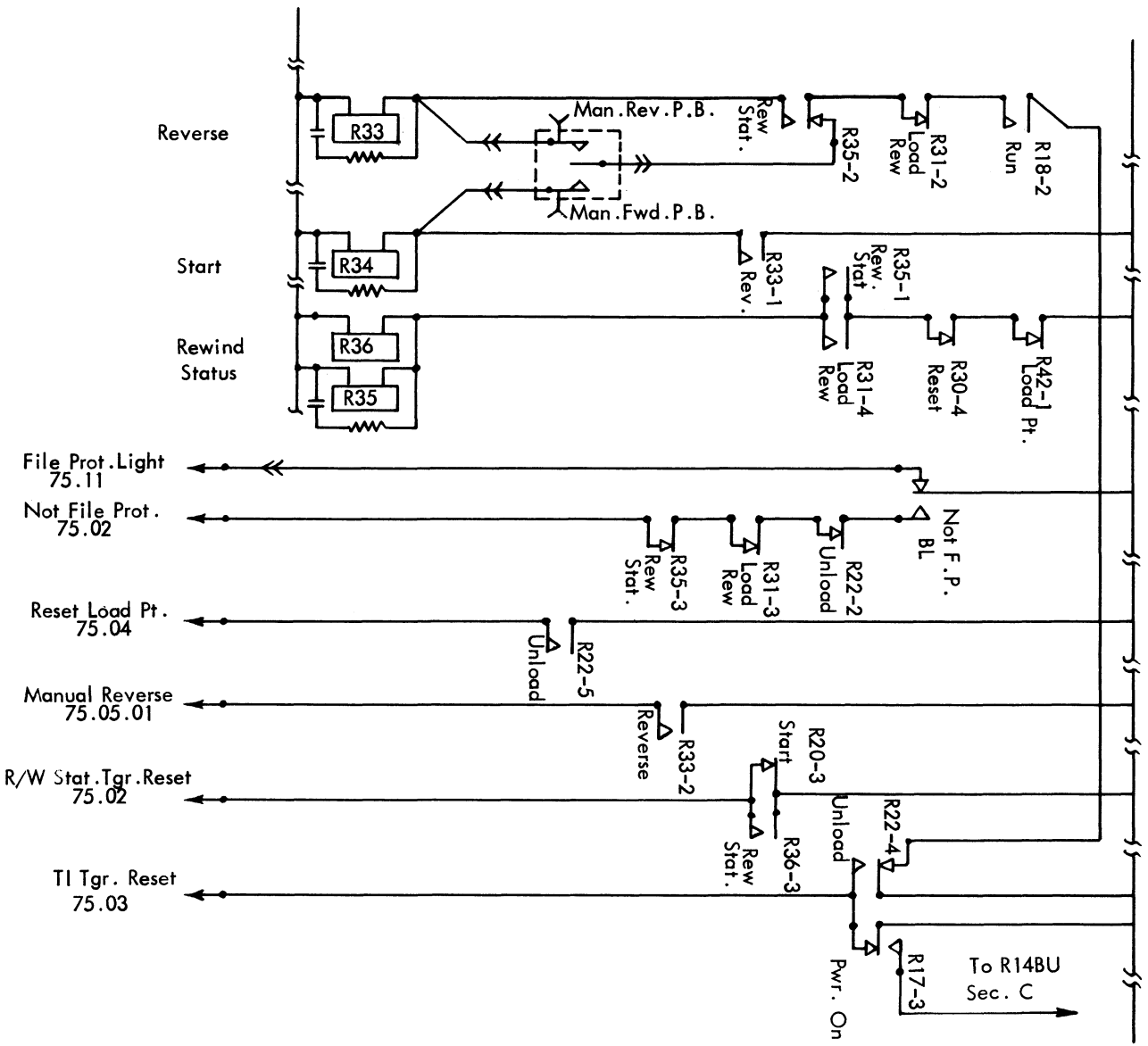
LOCATION CHART

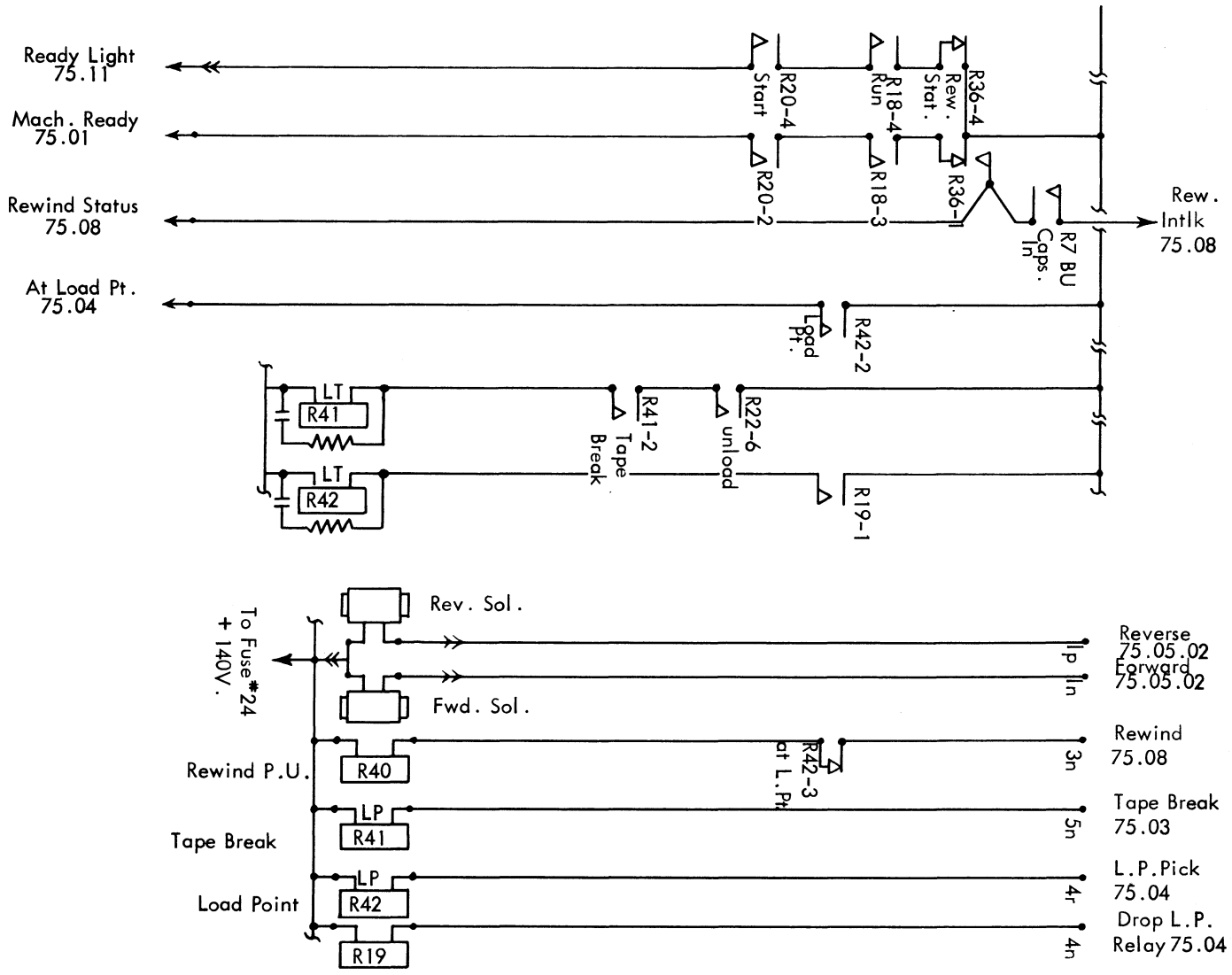

Start
Start (Ready)
R20
R21-1 Unload
R30-1 Reset
Start
R20-1
Manual Load Rew. 75.08
Load Rew.
LP
Unload
R21
Unload
48V
Reset
R30
Load Rew
R3 AL
Reset
Unload
R11 AL
Run
R1
R18
R41-1 Tape Break
R17-1 Power On
R14 AL Photo Light
R10 AL Tape Out Col.
R9 AL Tape Out Col.
No Vac. Sw.
AC Fuse
DC Fuse
Door Intlk.
Fuse Light 75.11
Not File Protection
F.P.
F.P. AL
F.P. Sensing Pin
Arm Latch Magnet
To Fuse 16 48V return
To Fuse 13 48V.
HD 8
Retracting Sol.
Retracting Sol. Latch
R6 AL Start Slow Rew
A
B


Power On
T.S.13
R17
Load-rewind
R3
R31
Unload Latch
LT
R21
R21-3
Unload Stop Latch
LT
R26
R26-3
Load-rewind
R2
Clutch
R4
Start Slow Rewind
R5
R6
Time delay
HD 7
Unload
R22
R11
R2 BL
Load Rew
Rew P.U.
R40-1
Photo Light
R14BU
To R17-3 Sec. J
R8 AL
Head Cover Not Down
Caps Out Left
Caps Out Right
To Fuse 13
48V
R2 AL
Load Rew
R22-7
Unload
R1 BL
Run
R7 AL
Caps In
R21-2
Unload
Start Slow Rew
R5 AL
R2 AU
Load Rew
R30-2
Reset
Arm Sw
R21-4
Unload


R34-1 Start
R6 BU
Start
Slow Rew
Load Rew
R31L6
Manual Start
75.05.01
R8 BL
Head Cover
Not Down
R10 BL
Tape Out
Right Col
R9 BL
Tape Out
Left Col.
R22-3
Unload
Take up Motor
Reverse
DP 1
R6 BL
Start
Slow
Rew
R8 BU
Head
Cover
Not
Down
R7 AU
Caps In
Take Up Motor
Start
HD 6
R12 BU
High
Speed
R26-2
Unload
Stop
R5 AU
Start
Slow
Rew
Time
Delay
High Speed
R12
R11 AU
Unload
Head Cover
Up Micro Sw.
R10 AU
Tape Out
Right Col
R9 AU
Tape Out
Left Col.
R5 BL
Start
Slow
Rew
Rewind Motor
DP 3
R7 BL
Caps In
Unload Stop
LP
R26
R9 BU
Tape
Out
L.Col
R10 BU
Tape
Out
R.Col
Head Cover
Not Down
R8
To Left Stop
500Ω Resistor
Head
Cover
Down
Micro Sw.


Capstans In (Retracted)
Tape Out Left Col.
Tape Out Right Col.
Retract Capstans
Phase 1
Phase 2
Phase 3
Capstan Motor
Clutch Transfer
Vacuum Motor
R7
R9
R10
HD 8
HD 1
HD 2
HD 3
DP 2
R13
HD 4
Caps. In Micro Sw
Left Col. Flapper Sw.
Right Col. Flapper Sw.
R11 BL Unload
R3 BL
R2 BU Load Rew.
R41-3 Tape Break
R1 AL Run
R17-4 Pwr. On
Load Rew
R3 BU
R11 BU
R26-1 Unload Stop
Unload
33Ω
R6 AU Start Slow Rew.
Head Cover Not Down
R8 AU
Unload
R22-8
R3 AU Load Rew
R35-4 Rew. Stat.
Unload
R22-1
R14
Photo Light
Tape End Light
Load Point Light
Tape Break Light
To Fuse 13 48V


Reverse
Start
Rewind Status
R33
R34
R36
R35
Man.Rev.P.B.
Man.Fwd.P.B.
Rew Stat.
R35-2
R31-2 Load Rew
R18-2 Run
R33-1 Rev.
R35-1 Rew. Stat.
R31-4 Load Rew
R30-4 Reset
R42-1 Load Pt.
File Prot.Light 75.11
Not File Prot. 75.02
Reset Load Pt. 75.04
Manual Reverse 75.05.01
R/W Stat.Tgr.Reset 75.02
TI Tgr. Reset 75.03
R35-3 Rew Stat.
R31-3 Load Rew
R22-2 Unload
Not F.P. BL
R22-5 Unload
R33-2 Reverse
R20-3 Start
R36-3 Rew Stat.
R22-4 Unload
R17-3 Pwr. On
To R14BU Sec. C


Ready Light
75.11
Mach. Ready
75.01
Rewind Status
75.08
At Load Pt.
75.04
Start
R20-4
R20-2
Run
R18-4
R18-3
Rew. Stat.
R36-4
R36-1
Caps. In
R7 BU
Rew. Intlk
75.08
Load Pt.
R42-2
LT
R41
LT
R42
Tape Break
R41-2
unload
R22-6
R19-1
To Fuse*24
+ 140V.
Rev. Sol.
Fwd. Sol.
Rewind P.U.
R40
Tape Break
LP
R41
Load Point
LP
R42
R19
R42-3
at L.Pt.
1p
1n
Reverse
75.05.02
Forward
75.05.02
3n
Rewind
75.08
5n
Tape Break
75.03
4r
L.P.Pick
75.04
4n
Drop L.P.
Relay 75.04

19.0 727 TAPE DRIVE TESTER

19.1 GENERAL

19.1.1 Purpose

The tape drive (727) tester (TDT) is designed to test mechanical and electrical functions of the Type 727 tape drive. The TDT tests all of the signals coming from and going to the drive. It supplies power to the drive through the normal power connector.

19.1.2 Description

The TDT is about 2' x 1'6" x 4' (high) and is mounted on casters. It contains one pluggable unit, an attached 12' signal cable terminated by a summary punch connector, a manual control plug, a power supply, a switch panel, and other associated circuitry. The TDT is supplied with a 12' power cable.

19.1.3 Power Supply

Power for the TDT is supplied through a four-prong three-phase line cord connector. The AC input requirements are 60 cycle, 3 phase, 208 volts ± 10%, 15 amps. Sequencing for the phases is as follows:

Phase 1 (power connector pin 1) becomes positive maximum before.
Phase 2 (power connector pin 2) becomes positive maximum before.
Phase 3 (power connector pin 3) becomes positive maximum.

When turning on the AC, wait 30 seconds to allow filaments to heat before turning on the DC. The DC switches may be turned on in any order as they are in series on the AC side of the power supply; all the DC comes up at the same time.

19.1.4 Power Arrangements

There are three methods of connecting the power when using the TDT (Figure 28):

1. The normal method. The TDT supplies power for both itself and the tape drive.
2. The TDT supplies its own power but the control unit supplies the power for the drive.
3. The control unit supplies power for both the drive and the TDT.

19.2 PURPOSE OF SWITCHES AND HUBS

Refer to Figure 29.

19.2.1 Switches

Address Select. This switch has 11 positions (0 to 9), corresponding to the dial switch on the tape drive unit, and an OFF position. If the tape drive address selector switch is set to the same address as the TDT address switch, it is selected by the TDT and the select light is turned on. This permits testing of all select lines to the tape drive.

Bit Switches. These seven switches determine whether ones or zeros are written in the corresponding tracks when the tape is moving in write status.

Go-Fb. This switch directs the output of the go-backward trigger (T_B) in the TDT either to the go line or the backward line in the tape drive unit.

Manual Forward-Manual Reverse. This switch is similar to the customer engineer's portable forward-reverse switch, and has direct control to move the tape forward or backward.

Read-Write. This switch performs several functions. It sets the status of the tape drive to either READ or WRITE. When set to WRITE, it allows the MV (multivibrator) to develop write pulses under control of the write frequency dial. When set to READ, it puts the MV under control of the start-stop frequency dial when the start-stop switch is turned on, and it sets read status in the tape unit.

Response Select. This dial switch has six wafers. Two select the particular track to be observed at the read bus or echo bus hubs. A third wafer determines the logical line that can be observed at the TU response hub. These lines are: select and rewind, select and at LP, select and TI off, select and TI on, select ready and read, select ready and write. The last three wafers are used for auto cycle.

Rewind. Depressing this button causes the tape to rewind if the tape unit is selected and ready.

Start. Depressing this button turns on the go-backward trigger (T_B) normally bringing up the go line. If the go-fb switch is set to forward-backward, however, the output of this trigger brings up the backward line.

Start-Stop. This switch is effective only if the read-write switch is set to READ. Turning it on then allows pulses developed by the MV (and gated by "select, ready and read") to operate the go-backward trigger through its binary input. Therefore, if the go-fb switch is set to GO, tape starts and stops at a frequency determined by the start-stop frequency dial. If the go-fb switch is set to forward-backward, the forward-reverse magnets alternate between forward and reverse.

Stop. Depressing this button turns off the go-backward trigger and thus brings down the go line, or the backward line, depending on position of the go-fb switch.

Start-Stop Frequency. This dial determines the frequency of starting and stopping the tape or of the alternating of the forward reverse magnet as described above, over a range of about 10 to 150 ms.

TI Set/Reset. This switch directly sets or resets the tape indicator trigger in the tape drive unit. When the tape indicator is on, neither the go nor the backward line may be brought up by the tester. "Select and TI on" holds off the go-backward trigger. When writing on tape the TI comes on and stops the tape motion.

Write Frequency. This dial determines the frequency of the write pulses initiated by the MV over a range of about a 20- to 100-usec period. It should be set for a period of 67.2 usec using a calibrated scope.

19.2.2 Hubs

Echo Bus. The write echo of the track selected by the response select switch can be observed at this hub.

Read Bus. The output of the pre-amp selected by the response select switch can be observed at this hub.

Go-Fb. This is the output of the go-fb trigger. This hub is used for a scope sync when measuring start-stop time or forward-reverse magnet transfer time.

TU Response. Logical lines from the tape drive, as specified by the response select switch, may be observed here.

Skew Sync. The "one" track output of the read bus is brought here for convenience in syncing the scope when measuring skew.

Write Pulses. Write pulses as they are sent to the tape drive are available here when the tape drive is in "select ready and write" status, the go-backward trigger is on, and the TI is off.

19.3 OPERATIONS

19.3.1 Preparation

To operate a tape drive from the TDT, connect the signal and power cables and turn the power on. Load the tape drive in the normal manner. Normally the tape has a load point and end-of-tape marker, and the file-protect ring is not removed. Press the start button on the tape drive to put it under external control. Select the tape drive by setting the address selector switch of both the drive and the TDT to the same address.

Unless otherwise noted, the start-stop switch is off, the manual switch and the TI switch are in neutral, and the go-fb switch is set to GO.

Any operations not mentioned in this section are referred to in section 19.2.

19.3.2 Writing

To write, turn the read-write switch to WRITE, set bit switches as desired, and push start button. If the tape indicator is not on, the tape moves forward and all ones are written on those tracks whose bit switches are set to one. Observe write pulses with the scope at the write pulse hub and adjust the write frequency dial for a period of 67.2 usec between pulses. Echo pulses of the track selected by the response select switch can be observed at the echo pulse hub. Pressing the stop button stops the writing operation.

When the start button is depressed, a shift from the go-backward trigger flips on the "write trigger reset single shot" sending out a 100-usec "reset write triggers" pulse. At the same time, write pulses, already being developed as a result of the fact that the read-write switch is set to WRITE, are gated out to the tape drive. Because there is no synchronization between them, it is possible that the fall of the

"reset write triggers" pulse could coincide with the fall of a write pulse. In this case (Case B, Figure 30) assuming all ones were being written, at time T_{100} some of the write triggers might be turned on and some might be turned off. Then these triggers would be flipping out of step with each other for the rest of that writing period. This condition could be observed at the write trigger neons when the writing is stopped. Usually, however, (as in Case A) all triggers are either on or off. Therefore, observing the write trigger neons shows whether the triggers are operating properly.

19.3.3 Reading

To read a tape, set the read-write switch to READ and press the start button. Tape moves forward in read status. The pre-amp output of the track selected by the response select switch can be observed with a scope at the read bus hub. Depressing the stop button stops the operation.

When in read status, the tape is read in start-stop fashion if the start-stop switch is turned on. The start-stop frequency dial controls the frequency of starting and stopping the tape. Unless the manual switch is used, tape cannot be read when the tape indicator is on.

19.3.4 Auto Cycle

The auto cycle feature on the TDT may be used to check the following operations of the tape drive: end-of-tape sensing, load-point sensing, high-speed rewind, vacuum switches, and flapper valves. The function of the auto cycle feature is to write the tape in a forward direction until an EOT reflective spot is sensed. The machine then rewinds the tape back to the load point. Upon reaching the load point, the tape unit starts writing again and the cycle is repeated.

This operation is accomplished in the following manner; upon sensing the EOT reflective spot, the signal "sel and TI on" goes through section E of the response select switch and back to the tape drive as "rewind." This signal causes the tape to rewind, and the signal "select unit rewinding" comes from the tape drive through section D of the response select switch and returns to the tape drive as "reset TI," thus turning off the tape indicator. Section F of the response select switch disconnects the "select and TI on" line that normally turns off the go-fb trigger. When the tape is rewound to load point, the ready line comes up and the tape drive starts writing again.

To put the machine into the auto cycle operation, the response select switch is set to AUTO CYCLE and the read-write switch is set to WRITE. Pressing the start button then puts the tape drive into auto-cycle operation. By placing the EOT reflective spot a few feet from the load point, the cycle can be made very short and the load point and EOT photo cells and single shots can be checked. If the EOT reflective spot is placed farther back on the tape so that the tape drive can just go into high-speed rewind upon sensing the spot, and the load point is placed just before this area, then the operation of the vacuum system and associated switches can be observed at a frequent rate.

With a full reel of tape on the tape drive and the EOT spot at the end of the tape, the tape drive can be auto-cycled to check the rewinding of a full reel at high speed.

The TDT and tape drive can be left to write and rewind for a period of time to check the reliability of high-speed rewind.

19.4 TEST PROCEDURES

19.4.1 Mechanical Adjustments of Tape Drive

The following chart lists the conditions necessary to adjust the forward-reverse magnet and the stop capstans in the drive unit, referred to in section 15.8.4 of this manual. In all cases, the start-stop switch is off. The tape drive is loaded with tape but the capstan and reel drive motor plugs are disconnected. Note that some alternate methods are given.

Status	G-FB Switch	Manual Switch	Button to Be Pressed	Other Conditions
Reverse go		Manual Backward		
Forward go		Manual Forward		
Forward go	Go	Neutral	Start	TU must be "select and ready."
Forward stop		Neutral	Stop	
Reverse stop	Forward-backward	Neutral	Start	TU must be "select and ready."
Reverse stop		Manual Backward	Stop	Remove R34 in tape unit.

19.4.2 Measurement of Start-Stop Time

To examine the start-stop envelope produced by the tape drive unit, set the oscilloscope as follows: external sync to go-fb hub, input to read-bus hub, vertical calibration at ten volts per major division, and horizontal sweep at 2 ms per major division (Figures 24 and 25).

The tape drive is loaded, selected, and ready. The tape is written with all ones in one or more tracks. Remove R34 to allow reading in reverse later.

The tester settings are as follows: the read-write switch is set to READ; the go-fb switch is set to GO; the manual switch is in neutral; the response select switch is set to a track on which all ones were written. When the start-stop switch is turned on, the tape moves forward in start-stop fashion. Now the start envelope can be observed using a plus external sync. A minus external sync shows the stop envelope.

To check the start-stop envelopes in backward motion, depress and hold down the stop button on the tester. Put the manual switch into manual reverse, and then release the stop button. The tape now reads in the reverse direction and the start-stop envelopes can be observed as before. CAUTION: Do not reverse the manual

switch while the tape is in motion. (Damaged tape may result when tape motion is changed in a go status.)

19.4.3 Measurement of Skew

A master tape (P/N 503928) for checking skew of the read-write head is provided for every installation. This test can be made using the tape drive tester.

Use the master tape and set up the tester and tape drive for reading. The relative timing between the 1 track and C track can be observed in the following manner.

Set the vertical calibration for ten volts per major division and the horizontal calibration for 5 usec per major division. Sync the scope on the skew sync hub and use the read bus hub as the input. By setting the response select switch to the 1 track (the sync pulse), the trace can be shifted so that the peak lines up with the center vertical line. Then set the response select switch to the C track, and observe the time position of the two signals. If it happens that the C track is leading the 1 track, the sync and signal probes will have to be reversed. A maximum of six-usec skew (flutter) between 1 and C tracks is within specifications (section 15.2.6).

19.4.4 Checking Forward-Reverse Magnet Transfer

The tape unit is loaded, selected, and ready. The tester switches are set as follows: read-write switch on READ, manual switch in neutral, the go-fb switch on forward-backward, and the start-stop switch on. Alternately, the forward and reverse magnets are energized at a frequency determined by the start-stop frequency dial.

The scope is set to a vertical calibration of 20 volts per division and a horizontal sweep of four ms per major division. The forward-magnet transfer wave form can be seen with the scope input at 1p and a positive external sync from the go-fb hub. For the reverse-magnet wave form, the input signal is taken from 1n with the positive external sync from the go-fb hub (Figure 26).

19.4.5 Checking Moving Coil Wave Form

The tester set-up is the same as for checking forward-reverse magnet transfer except that the go-fb switch is set to GO. The moving coil now oscillates up and down. The scope is set for .5 volts per division and five ms per major division. The scope is not grounded as the input is taken from across edge connectors 1r and 2n. CAUTION: The scope is about 100 volts above ground. Use an external sync from the go-fb hub and change polarity to get a start pulse and a stop pulse (Figure 27).

20.0 PURPOSE OF RELAYS

R1, 18, Run (09.04)	They are always picked except when unloaded. When dropped, they indicate a failure in one of the machine interlocks, such as a blown fuse, tape breakage, or DC power failure.
1AU, 1BU (10.01)	When down, they allow full brake to both stop clutches.
1AL (09.06)	It controls phases 1 and 2 AC power.
1BL (09.04)	In case of an interlock failure, drop R4 if it was up, so the 1AU and 1BU pts. can brake both reels.
18-2 (09.01)	In case of an interlock failure during low-speed rewind, stop tape by dropping the manual start line.
18-3,4 (09.03)	Insure that the interlock conditions are satisfied before allowing the ready line to be raised, or the ready light to be turned on.
R2, Load rewind (09.04)	It is picked when the load rewind button is pressed. If this occurs in an unload status or in the high-speed area, R2 holds until both capstans are extended. If load rewind button is pressed when loaded in the slow-speed area, R2 is picked until the button is released.
2AU (09.04)	Pick R5, 6, HD7 while rewinding when or if the reel arm switch is closed, or when the reset key is pressed while rewinding in the high-speed area.
2AL (09.04)	It is the hold point for R2.
2BU (09.06)	When initiating a rewind in the slow-speed area, it prevents a short pick to HD8 when R2 drops. (This would occur when the load rewind button is released, if using manual control.)
2BL (09.05)	Pick R3, 31. Trip R21, 26, if latched.
R3, R31, Load rewind (09.05)	Same as R2
3AU (09.01)	It shunts the load point and tape end lights during load rewind until the capstans extend. This makes the tape break light brighter during the time it might be used. It also prevents the end-of-file mark from causing a false tape break indication.
3AL (09.04)	It allows the run relays to hold during load rewind when tape is not in the columns. It also prevents dropping the run relays if the tape break light burns out during a high-speed rewind. Dropping the run relays would put full brake on both reels.
3BU (09.06)	Pick R13 during load rewind until the capstans are out. (See R13.)
3BL (09.06)	When a rewind in the slow-speed area is initiated, it prevents a short pick to HD8 when R2 picks. (This would occur when the load rewind button is pressed, if using manual control.)
31-2 (09.01)	Prevent getting a reverse start during load rewind until both capstans are extended.

31-3 (09.01)	This is for added protection to insure that the tape is file protected when rewind is initiated, before R35 is picked.
31-4 (09.01)	Pick the rewind status relays.
31-6 (09.02)	During load rewind, until the capstans are extended, the R6, 8, 9 and 10 pts. have control of the manual start line.
R4, clutch (09.04)	It is picked while load rewinding until the capstans are extended, or while unloading. R4 is picked whenever tape is being lowered into or taken out of columns.
4AL, BL (10.01)	When the stop clutches are energized, it is with half power.
R5,6, start slow rewind; HD7, time delay (09.04)	They are picked while rewinding when, or if, the reel arm switch is closed, or when the reset key is pressed while rewinding in the high-speed area. They hold until both capstans are extended.
5AU (09.05)	At the start of load-rewind from a loaded status, R5AU determines whether to raise the head cover.
5AL (09.06)	Hold R5, 6, HD7.
5BL (09.05)	Drop R12 and DP3 when the reel arm switch closes during high-speed rewind. This starts slowing tape down.
6AU (09.06) N/C	It allows the capstans to be retracted when starting a high-speed rewind or unload operation.
N/O	Energize HD8 in preparation to letting capstans out during the load rewind from an unloaded status, or during loading portion of a high-speed rewind.
6AL (09.06)	Energize the solenoid magnet latch in preparation to extending the capstans.
6BU (09.02)	It allows a manual start when unloaded. This is the only condition when the R9BL and R10BL pts. do not indicate the true status of the columns.
6BL (09.05) N/C	Allow the take-up motor (HD6) to run while unloading and while raising the head cover during high-speed rewind. When open, the timer point has control of the take-up motor.
N/O	Reverse the take-up motor field.
R7, Capstans in (09.05)	It is picked when the capstans are fully retracted.
7AU (09.05) N/C	This allows HD8 to be picked to retract the capstans starting a high-speed rewind operation. When the capstans are retracted, this point opens the circuit to HD8.
N/O	This prevents a manual start while unloading until the capstans are retracted. They prevent running the take-up motor (HD6) until the capstans are retracted.
7AL (09.04)	This point insures that 1/2 brake cannot be placed on the reels until the capstans are in. This is essential if the unload button is pressed while the unit is rewinding at slow speed.
7BU (09.03)	It prevents the end of file reflective spot from being recognized as a tape break.
7BL (09.05)	If the tape should go into either column when coasting to a stop following a high-speed rewind, R7BL allows the take-up motor to start without waiting for the time delay pt. to close.

R8, Head cover not down (09.05)	Pick R8 when the head cover is not all the way down. Hold it until the head cover is all the way down and tape is in both columns.
8AU (09.06) N/C	This runs the capstan motor only when using the capstans or when moving the capstans in or out.
N/O	This allows the capstans to extend (drop HD8) during load rewind when the head cover is all the way down and tape is in both columns.
8BU (09.05)	When lowering tape into the columns during load-rewind, stop the take-up motor when the holding conditions on R8 are satisfied.
8BL (09.02)	This allows R34-1 to have complete control of the manual start line when the head cover gets down and tape gets in both columns.
R9, 10, Tape out of columns (09.05)	R9 is controlled by the left column microswitch; R10, by the right. When vacuum is up, these relays are picked only when tape is out of their respective columns.
9, 10AU (09.05)	These insure that tape is out of both columns before: (a)stopping the vacuum motor when unloading (LP R26), (b) starting the rewind motor for high-speed rewind (DP3, R12).
9, 10AL (09.04)	They drop the run relays if tape should break during any operation where tape is being moved by the drive capstans.
9, 10BU (09.05) N/C	These prevent braking the left reel while slowing down from a high speed rewind.
N/O	These hold R8 until tape gets in both columns.
9, 10BL (09.02)	These drop the manual stop line when tape gets into either column. This occurs during load rewind when tape is being lowered. It insures that tape will get into both columns.
R11, 22, Unload (09.05)	This is picked when R21, unload is up.
11AU (09.05)	When the head cover is up and tape is out of both columns, one of two possible conditions exists: (a) unload is completed, (b) it is ready to start high speed motor. If R11 is picked, the unload button has been pressed, so example (a) applies.
11AL (09.04)	While unloading, keep the run relays up until the operation is completed.
11BU (09.06)	Pick R13. (See R13.)
11BL (09.06)	Retract the capstans when an unload operation has been started.
22-1 (09.01)	Place all three photo lights in series with R14 while unloaded. Thus in order to start a load rewind operation from an unloaded status, all three photo lights must be conducting, i.e., R14 must be picked.
22-2 (09.01)	This is protection in case the read-write status trigger filament should burn out. While unloaded, and while unloading, the write heads and erase heads cannot conduct.
22-3 (09.02)	Put the moving coil in a start status when unloaded for ease in changing reels.
22-4 (09.02) N/C	Drop R33 and R34 to stop tape in case the unload button is pressed while the machine is rewinding at low speed.
22-5 (09.02)	Drop the load point relay.

22-6 (09.03)	Latch trip the tape break relay when unloading after a tape break.
22-7 (09.04)	Drop R2 if the unload button is pressed during load rewind.
22-8 (09.06)	If a condition existed where the capstans were extended while in unload status, the capstans would automatically be retracted. R22-8 runs the capstan motor while the capstans are being retracted.
R12, DP3, High-speed rewind motor (09.05)	It is picked during high-speed rewind when all conditions are met to actually start moving tape (capstans in, tape out of both columns, head cover up). R12 and DP3 drop when the reel arm switch makes.
12AL, BL (10.01)	Remove 1/2 power to both stop clutches.
12BU (09.05)	Turn off the take-up motor (starting a high-speed rewind from a loaded condition) when tape is out of the columns.
R13, Clutch transfer (09.06)	It is picked when unloading, while unloaded, and during load rewind until both capstans are out. Whenever lowering or raising tape into or out of the columns, R13 is picked.
13AL, BL (10.01) N/C N/O	Allow the vacuum column switches to control the reel clutches, keeping tape in the center third of the columns. Remove reel clutch control from the vacuum column switches, allowing only the stop clutches to be energized.
R14, Photo light (09.01)	It is always picked when 48v power is on machine. When dropped, it indicates a burned-out photo light.
14AL (09.04)	Drop the run relays if any photo light burns out while low-speed rewinding, or if the load point or tape end light burns out while reading or writing.
14BU (09.04)	Prevent starting a load rewind operation if: (a) unloaded and any photo cell is burned out, (b) loaded and the load point or tape-end photo light is burned out.
R17, Power on reset (09.01)	It is picked when all the DC supplies are up in the control unit, and the 48v supply is up in the tape drive.
17-1 (09.04)	Drop the run relays in case of DC power failure.
17-3 (09.02)	It supplies a power-on reset to the tape indicator trigger in case power is brought up on a loaded machine.
17-4 (09.06)	Phase 3 is picked separately to allow the vacuum motor to run. (Phases 1 and 2 cannot pick until the vacuum motor is up to speed.)
R19. Load point reset (09.03)	It is picked while unloading and when unloaded. It is also picked when starting from load point until the load point relay drops. The load point relay was not latch tripped directly because a standard latch trip relay with the correct impedance is not available.
19-1 (09.03)	Latch trip the load point relay when leaving load point.
R20, Start (09.04)	It is picked with the start key, providing the door is closed and the machine is not unloaded. It holds until the door is opened, or until the reset key is pressed.

20-1 (09.04) N/C	It prevents unloading or load rewinding a tape unit that is ready, without first pressing the reset button.
N/O	Hold for R20.
20-2 (09.03)	The conditions as stated for R20 are a partial requirement for bringing up the machine ready line.
20-3 (09.02)	When closed, it provides a constant reset to the read-write status trigger. Thus unload or load rewind cannot be initiated in write status.
20-4 (09.03)	Same as R20-2, controlling the ready light.
R21, Unload pickup-latch pick (09.04)	It is picked when the unload button is pressed, providing the door is closed and the start relay R20 is not up.
Latch trip (09.05)	R21 will be tripped when starting a load rewind operation.
21-1 (09.04)	It prevents the start relay R20 from being picked.
21-2 (09.04) N/C	Allow R4 to be picked while load rewinding.
N/O	Pick R4 while unloading.
21-3 (09.05)	Prevent continuous energization of R21LT while load rewinding.
21-4 (09.05)	Pick unload relays R11 and R22.
R26, Unload stop latch pick (09.05)	It picks at the completion of an unload operation when the head cover is up and tape is out of both columns.
Latch trip (09.05)	Drop R26 when a load rewind operation starts.
26-1 (09.06)	Stop the vacuum motor (HD4).
26-2 (09.05)	Stop the take-up motor (HD6) when unload is completed.
26-3 (09.05)	Prevent continuous energization of R26LT when load rewinding.
R30, Reset (09.04)	It is picked as long as the reset button is pressed, providing the door is closed.
30-1 (09.04)	Drop the start relay R20. This takes the machine out of ready status.
30-2 (09.04)	Pick R5, 6, HD7 if the reset button is pressed during a high-speed rewind. This simulates the reel arm switch closing.
30-4 (09.01)	Drop the rewind status relays. If the reset button is pressed a short time during a high-speed rewind, the rewind status relays pick again when the reset button is released.
R33, Manual reverse (09.01)	It is normally picked during load rewind when R31 drops. This occurs when both capstans are extended. It holds until load point is reached. The customer engineer's external reverse switch, or the reverse switch on the tape tester can also be used to pick R33 when the tape unit is not in rewind status.
33-1 (09.01)	Pick manual start R34.
33-2 (09.02)	Bring up the manual reverse line in order to energize the reverse magnet.
R34, Manual start (09.01)	It is normally picked with R33-1. The customer engineer's manual forward switch, or the forward switch on the tape

	tester can also be used to pick R34 when the tape unit is not in rewind status.
34-1 (09.02)	Bring up the manual start line in order to energize the moving coil and move tape.
R35, 36, Rewind status (09.01)	They pick when the load rewind button is pressed (31-4) if the tape is not already at load point. They hold until load point is reached.
35-1 (09.01)	Hold point for R35, 36.
35-2 (09.01) N/C	Allow external forward-reverse switch to control R33, R34.
N/O	Allow a manual reverse at a time determined by R31-2.
35-3 (09.01)	It is protection if the read-write status trigger should burn out. During rewind, the write and erase heads cannot conduct.
35-4 (09.01)	This point allows the machine to stop when the capstans are extended, following a high-speed rewind during which the tape break light burned out. This is essential because the unit is not always unloaded after load point is reached.
36-1 (09.03) N/C	Prevent the machine from being ready while rewinding.
N/O	Bring up the rewind status line and allow R7BU to control the rewind interlock line.
36-3 (09.02)	It is added protection to insure that the read-write status trigger is held off while rewinding.
36-4 (09.03)	Prevent the ready light from being on while rewinding.
R40, Rewind pick up (09.03)	It is picked: (a) by the load rewind button if the tape is not at load point, the machine is in read status, the start relay R20 is down, and the door is closed, (b) by the start rewind line from the control unit if the tape is not at load point and the tape unit is selected and ready. R40 holds until: (a) the load rewind button is released, (b) the select and ready line goes down.
40-1 (09.04)	Pick R2 to start a rewind operation providing the photo lights are good.
R41, Tape break (09.03)	It picks if tape breaks while rewinding with the capstans in
Latch pick	(high-speed).
Latch trip	R41 drops when the unload button is pressed following a tape break.
41-1 (09.04)	Drop the run relays in case of a tape break.
41-2 (09.03)	Prevent energizing R41LT continuously while unloaded.
41-3 (09.06)	Prevent continuous energization of HD8 in case tape breaks while slowing down after a high-speed rewind.
R42, Load point	It is latch picked when the load point passes under the load-point photo cell. It is latch tripped when leaving load point (pick R19).
42-1 (09.01)	Drop the rewind status relays when load point is reached.
42-2 (09.03)	(a) Prevent R19 from being picked every time the start line goes up. (b) Allow "select and at load point" to go plus if the tape unit is selected.
42-3 (09.03)	Prevent starting a rewind operation if already at load point.

21.0 TAPE DRIVE CEM LISTING

CEM #	
57	Depot parts listing
60	Photo lamp
61	Motor drive belts
62	System fuses
66	Cleaning fluids
75	Preventive maintenance
78	Correction of extraneous pulses
80	Pluggable unit changes
86	Photo cell
92	Tape drive tester
95	Mechanical adjustments
96	False load point and tape break indicator
100	Cleaning procedure
102	Humidity conditions
105	Tape break circuitry
107	Shortage of 6072 tubes
111	Test for erase and read-write head polarity
112	Tube interchangeability
113	Cleaning procedures
114	Capstan drive belt
118	Care of tape
121	Covers
124	New parts
126	Ground connection - SP receptacle
127	Logic changes
130	RC networks across relays
131	New EDPM part numbers
133	-12 clamp reset diodes
142	Test tape storage
154	Moving coil circuits
155	Dummy fuses
156	Tape interlock change
164	Air filters
180	727 check-out procedure using tape drive tester

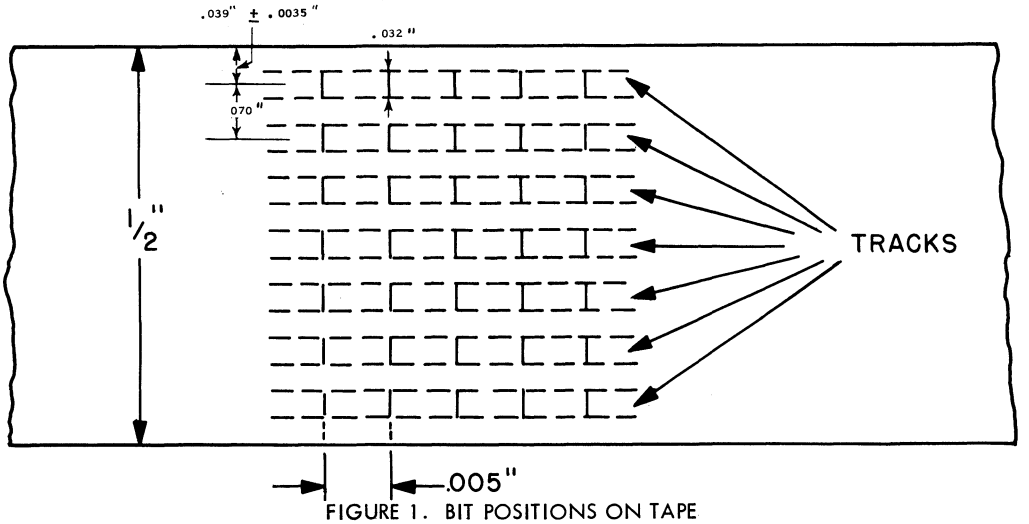


FIGURE 1. BIT POSITIONS ON TAPE

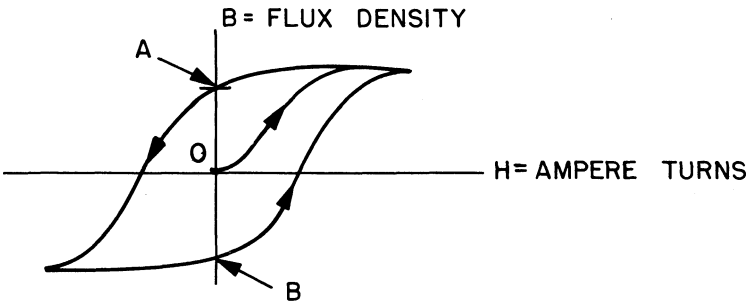


FIGURE 2. B-H CURVE

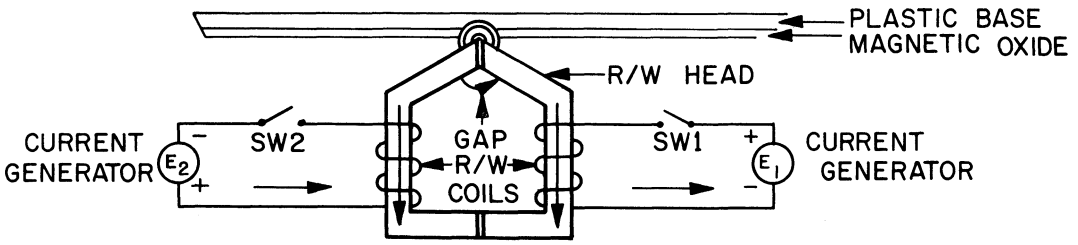


FIGURE 3a.

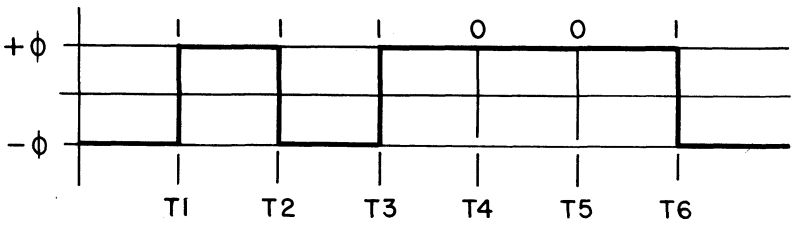


FIGURE 3b.

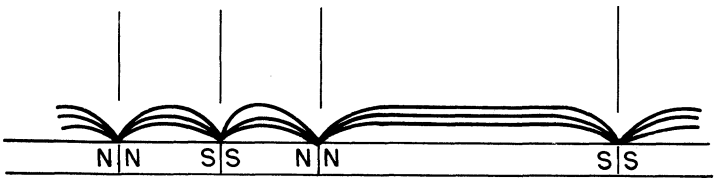


FIGURE 3c.

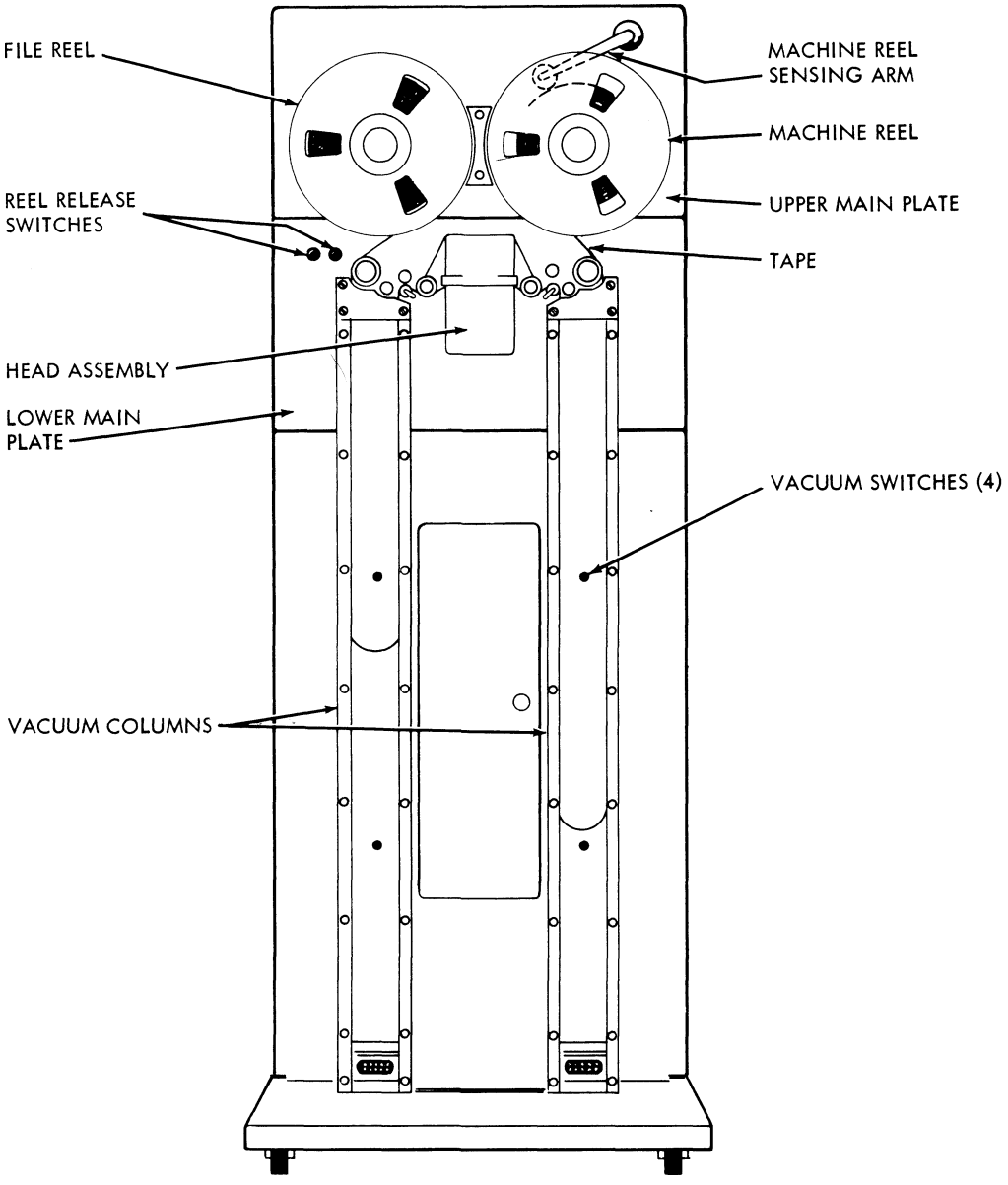


FIGURE 4. FRONT VIEW

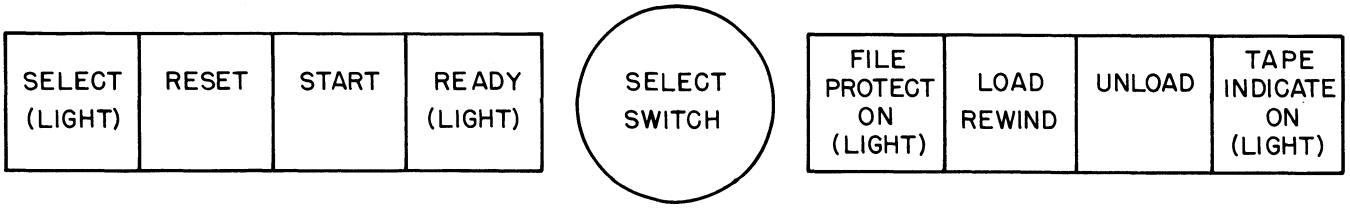
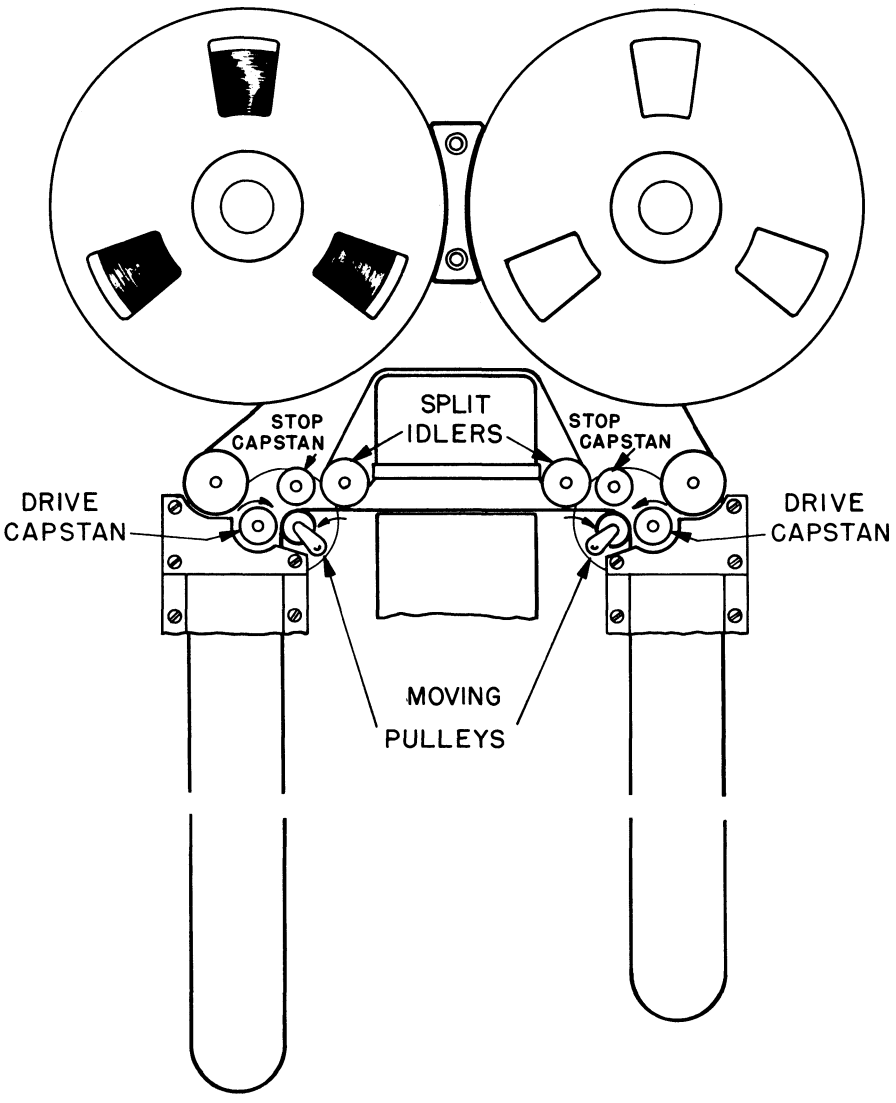
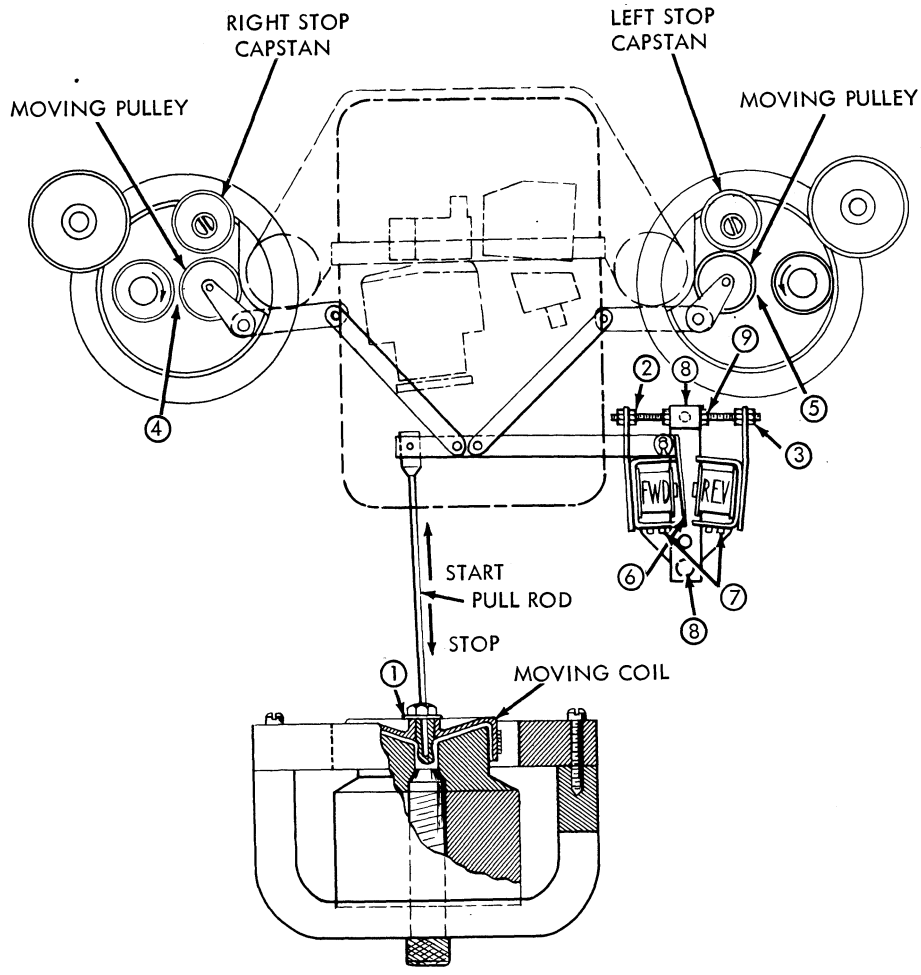


FIGURE 5. PANEL BUTTONS AND LIGHTS

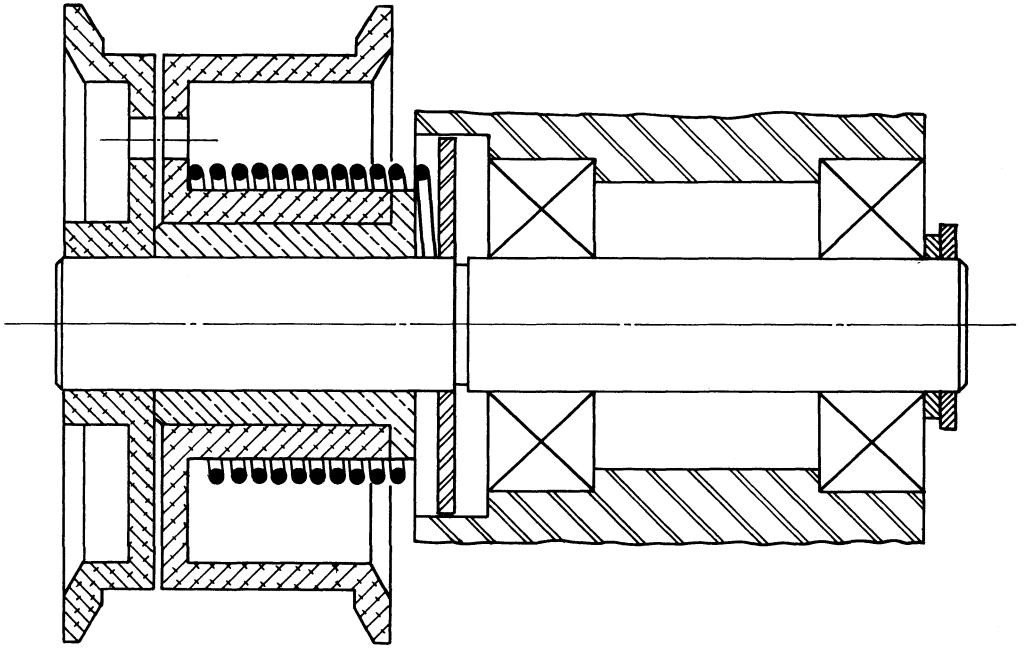


PATH OF TAPE THROUGH MACHINE
FIGURE 6



MECHANISM SHOWN IN A FORWARD - STOP STATUS

FIGURE 7. MOVING COIL AND LINKAGE REAR VIEW



SPLIT IDLER ASSEMBLY
FIGURE 8

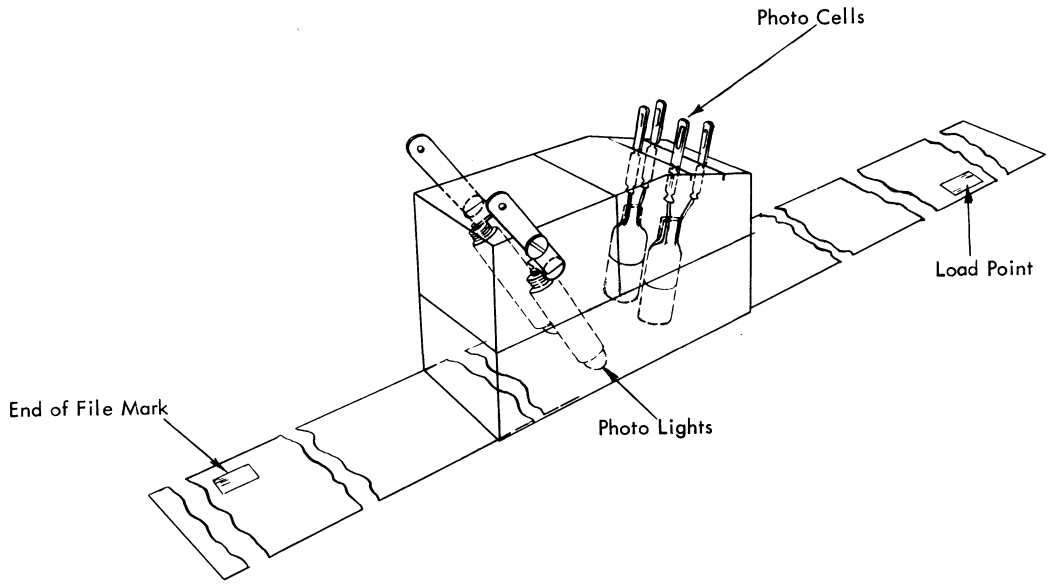


FIGURE 9. PHOTO - CELL SENSING

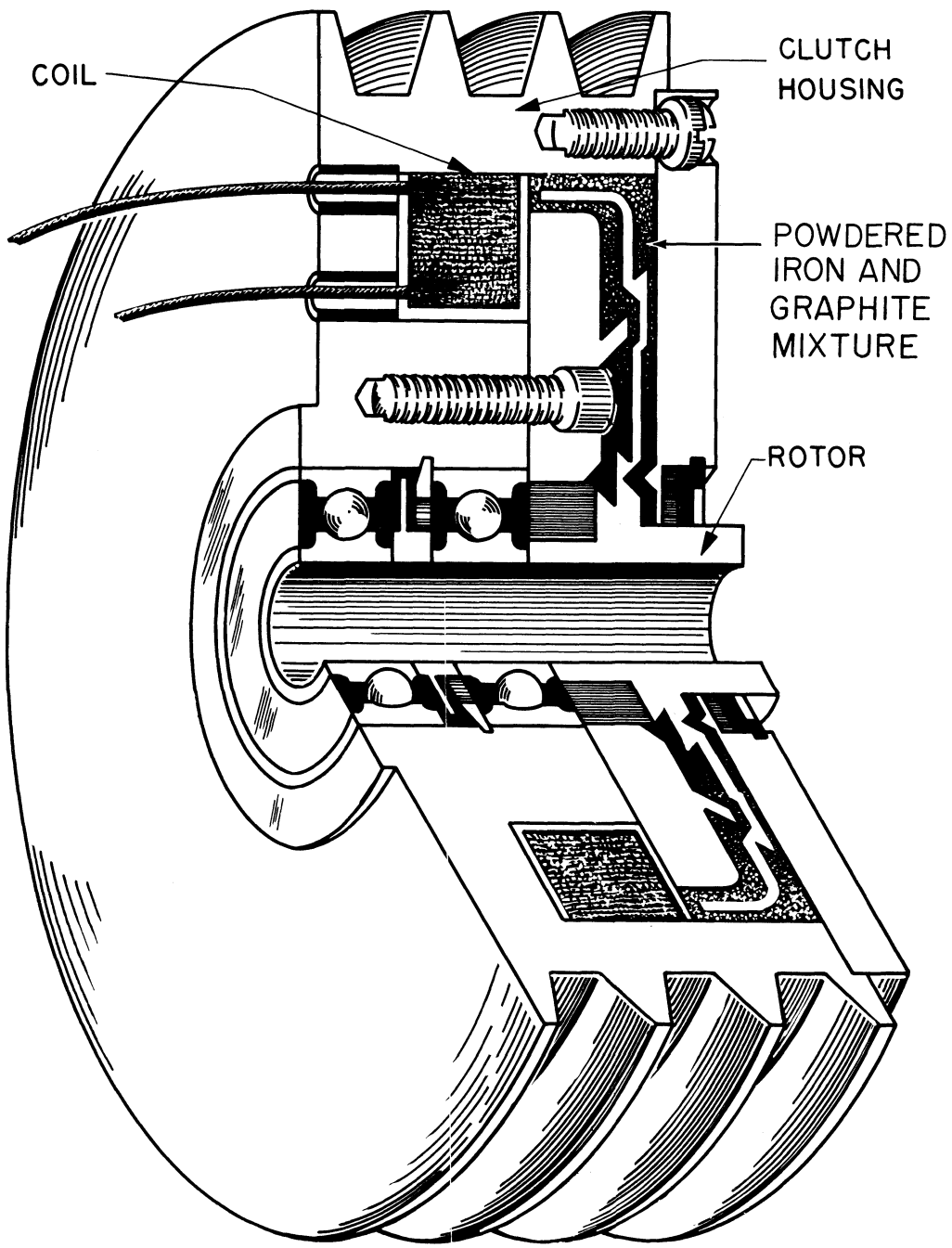
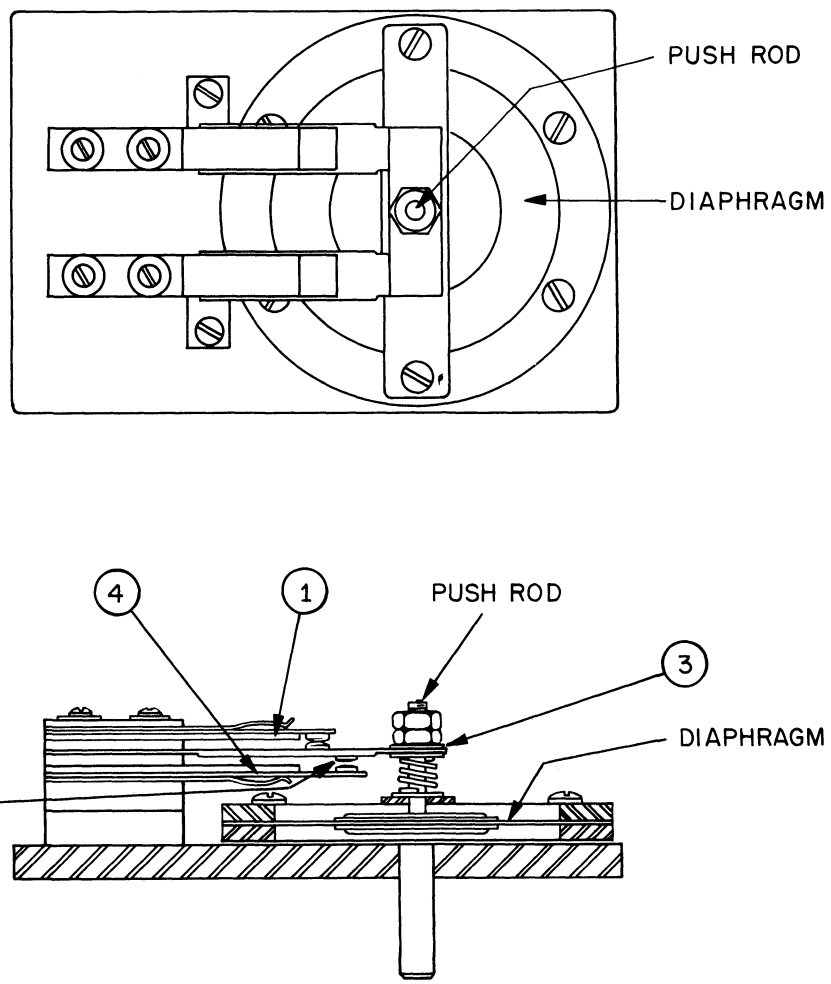


FIGURE 10
MAGNETIC CLUTCH



VACUUM COLUMN SWITCHES
FIGURE 11

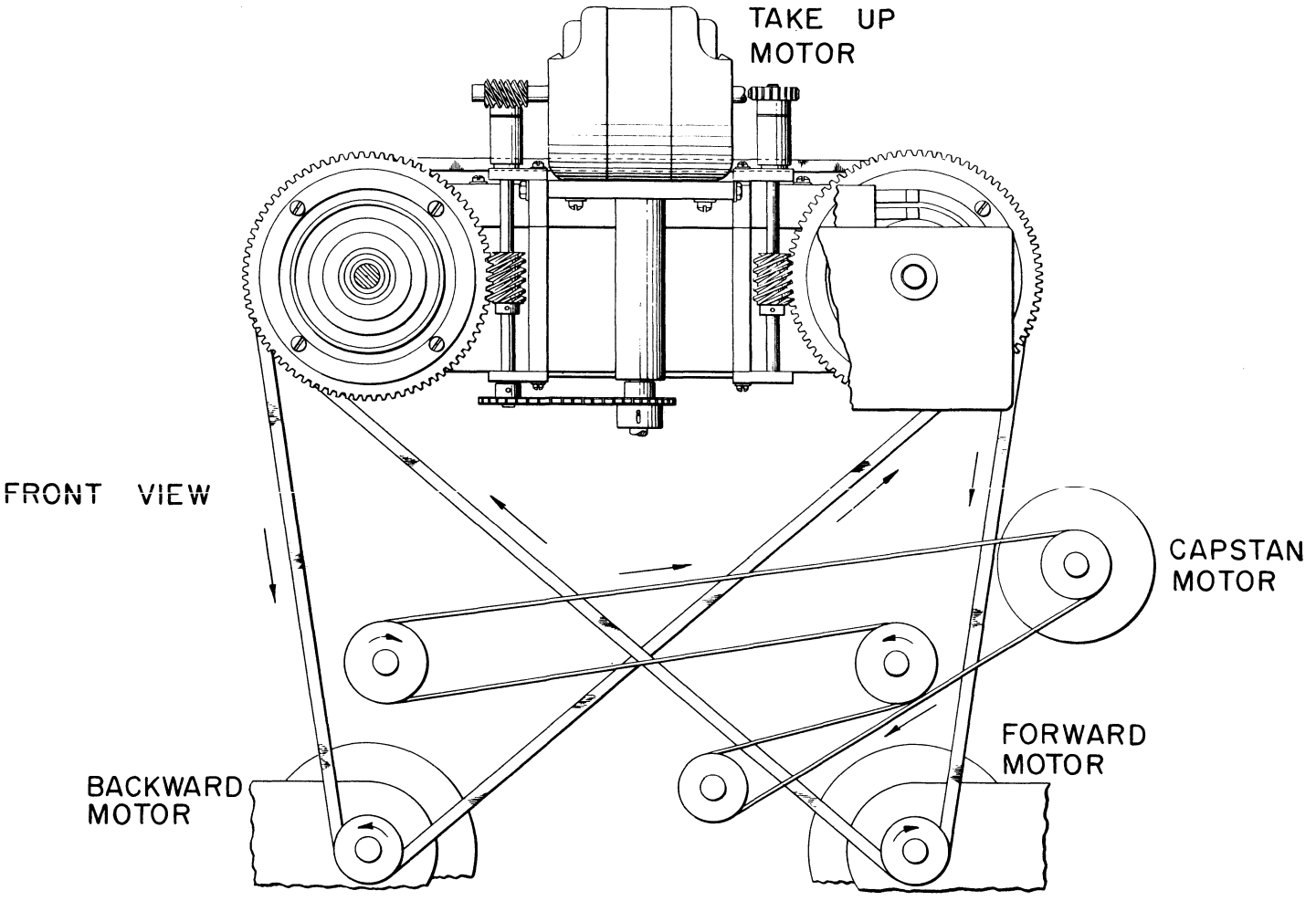


FIGURE 12. DRIVE MOTORS AND PULLEYS

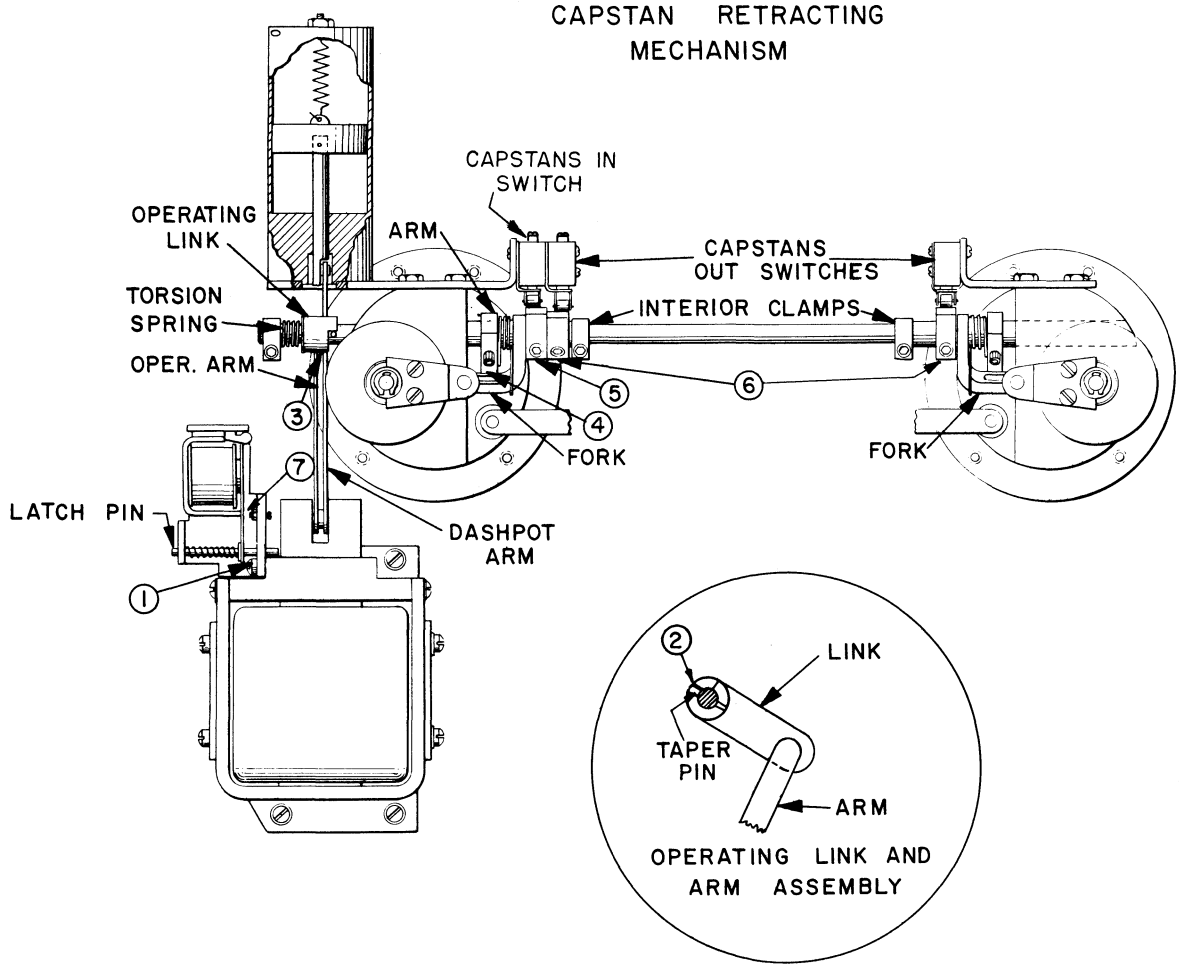

CAPSTAN RETRACTING MECHANISM
CAPSTANS IN SWITCH
OPERATING LINK
ARM
CAPSTANS OUT SWITCHES
TORSION SPRING
INTERIOR CLAMPS
OPER. ARM
3
5
6
4
FORK
FORK
7
LATCH PIN
DASHPOT ARM
1
2
LINK
TAPER PIN
ARM
OPERATING LINK AND ARM ASSEMBLY

FIGURE 13

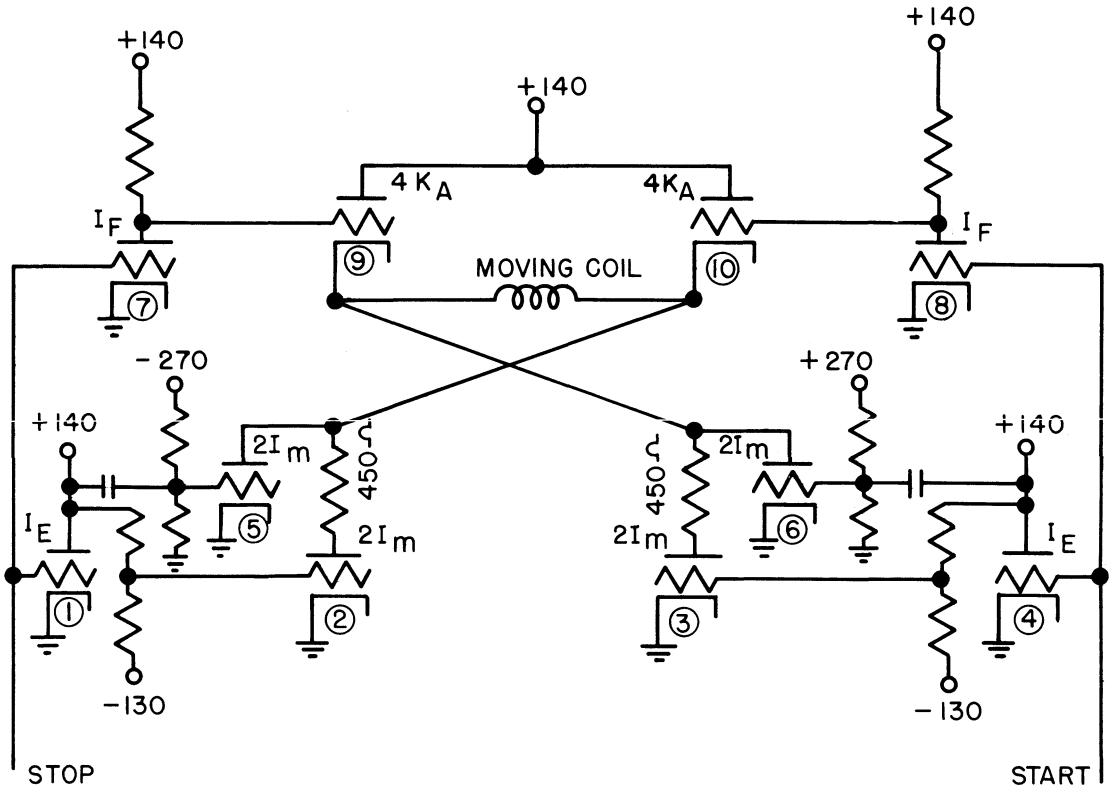


FIGURE 14. MOVING COIL CIRCUIT

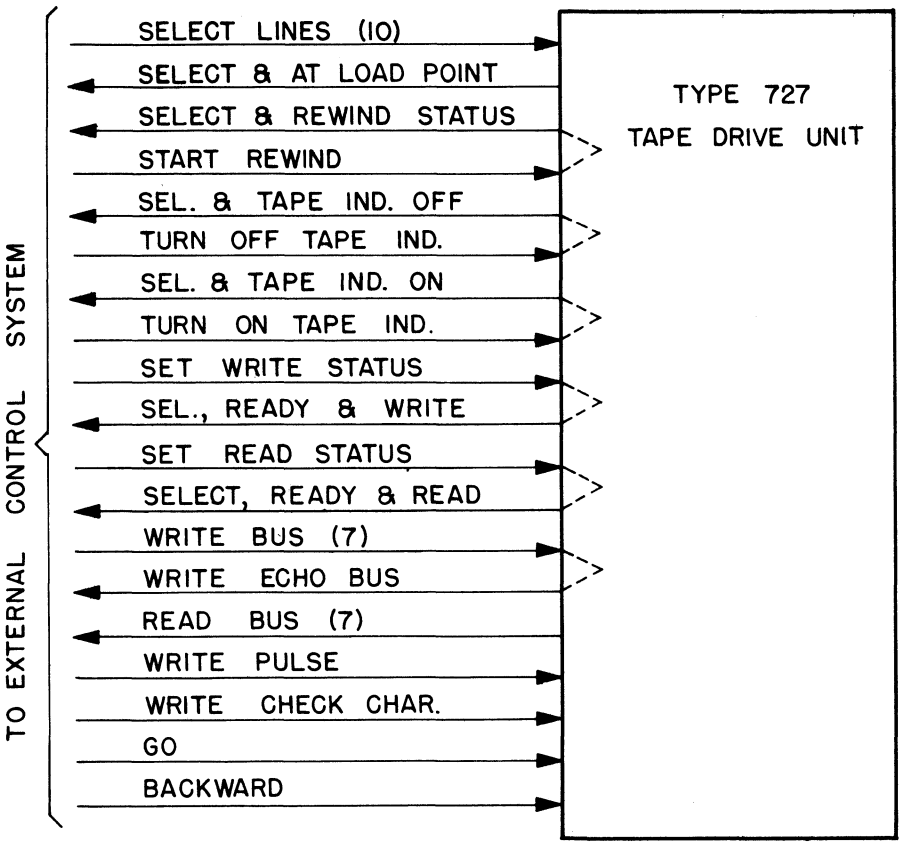


FIGURE 15. CONTROL LINES

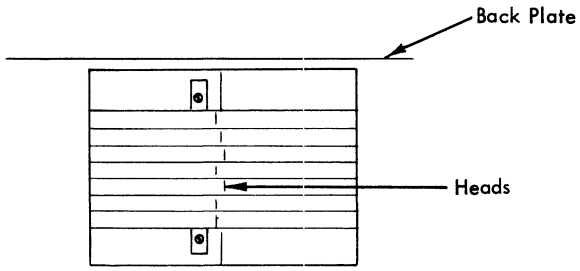


FIGURE 16a. TOP VIEW OF READING HEAD
SHOWING HEAD SKEW (MECHANICAL)

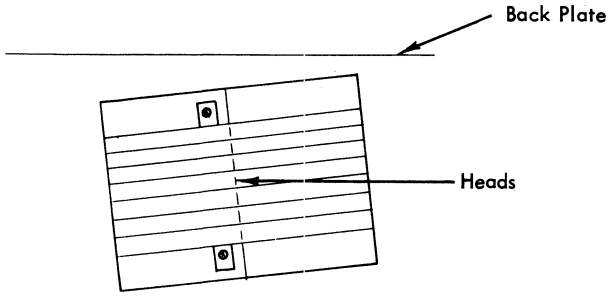


FIGURE 16b. TOP VIEW OF READING HEAD
SHOWING POOR HEAD ALIGNMENT

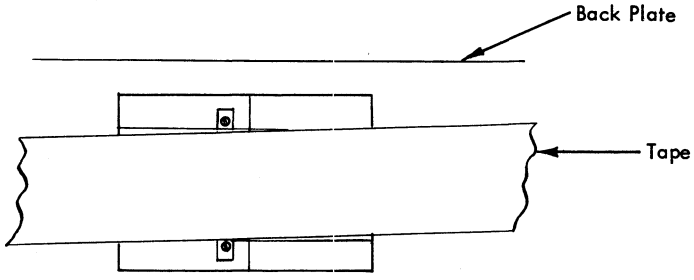


FIGURE 16c. TOP VIEW OF READING HEAD
SHOWING POOR TAPE ALIGNMENT

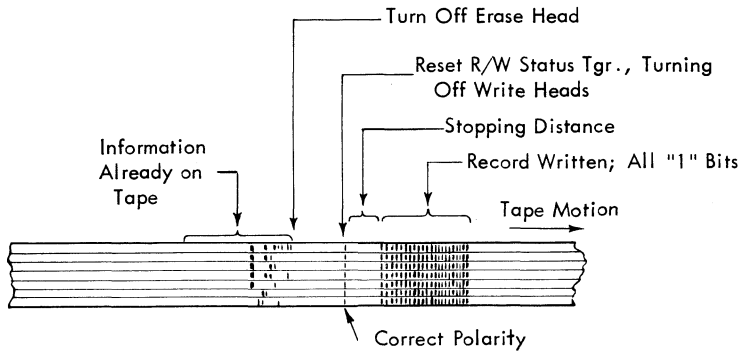


FIGURE 17a

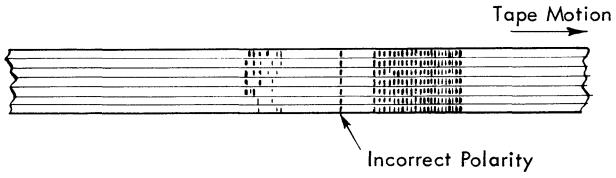


FIGURE 17b

FIGURE 17. ERASE HEAD POLARITY

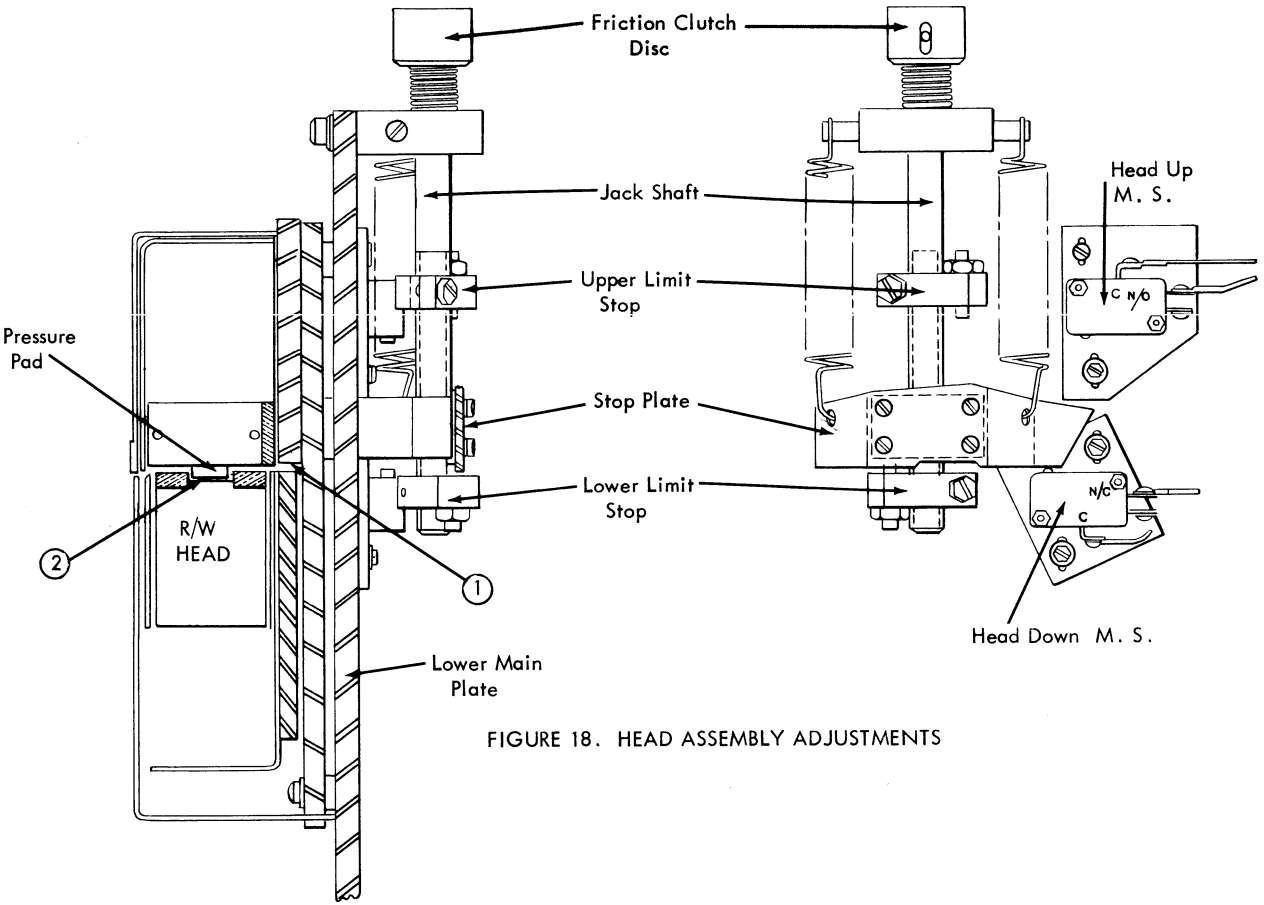


FIGURE 18. HEAD ASSEMBLY ADJUSTMENTS

TAPE CLEANER

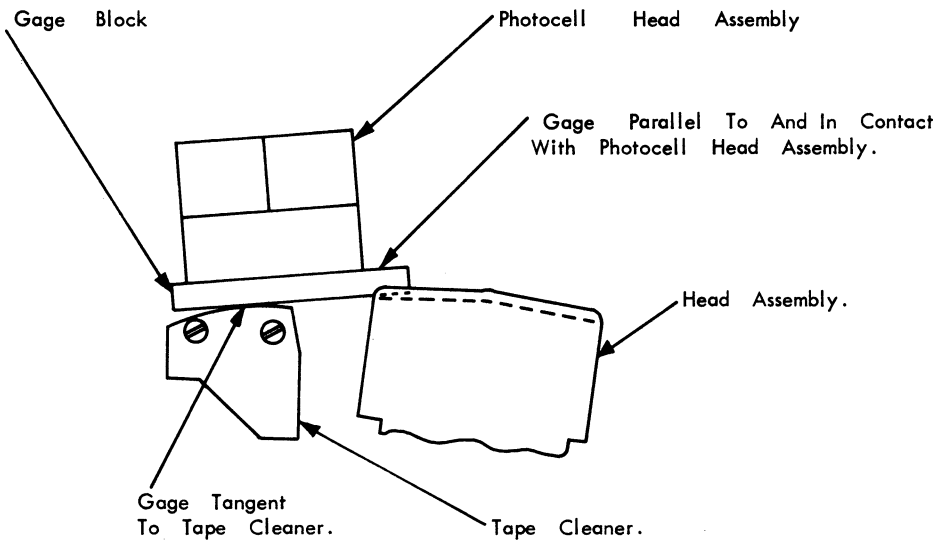


FIGURE: 19

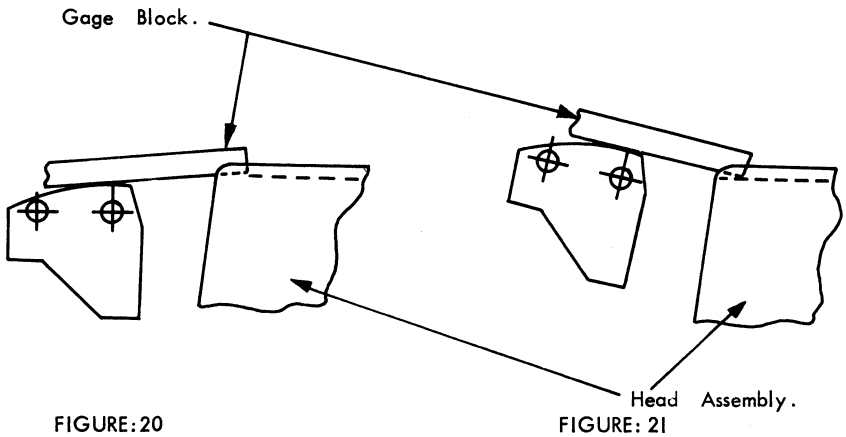
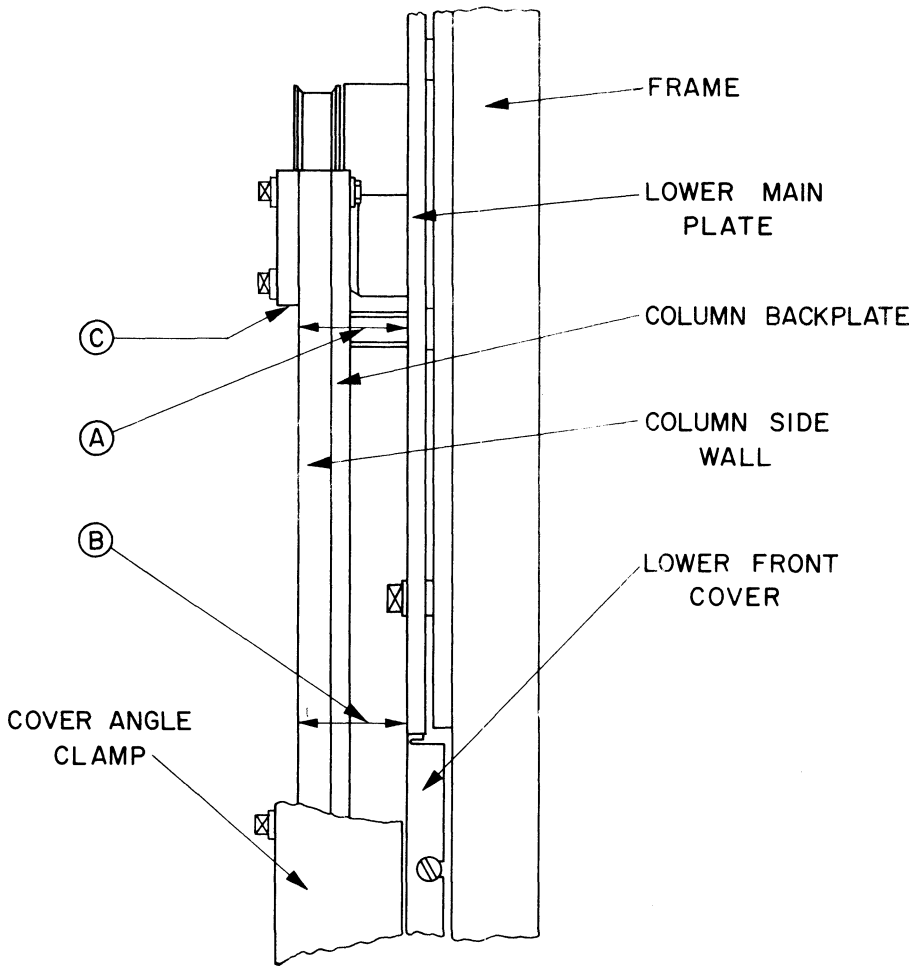


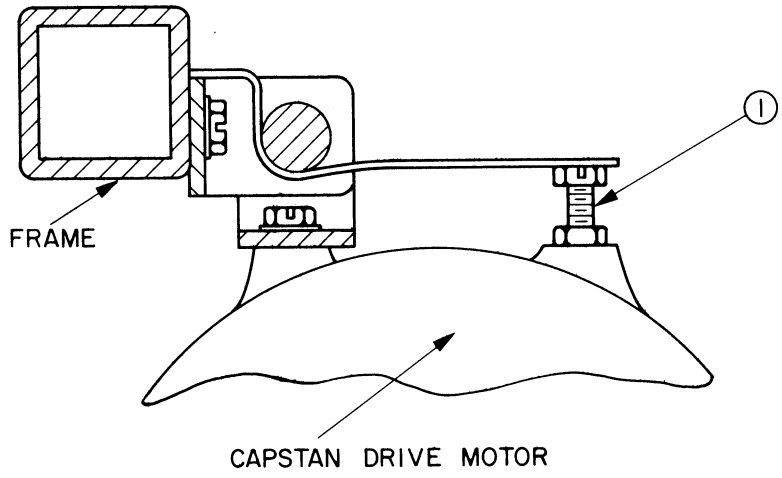
FIGURE: 20

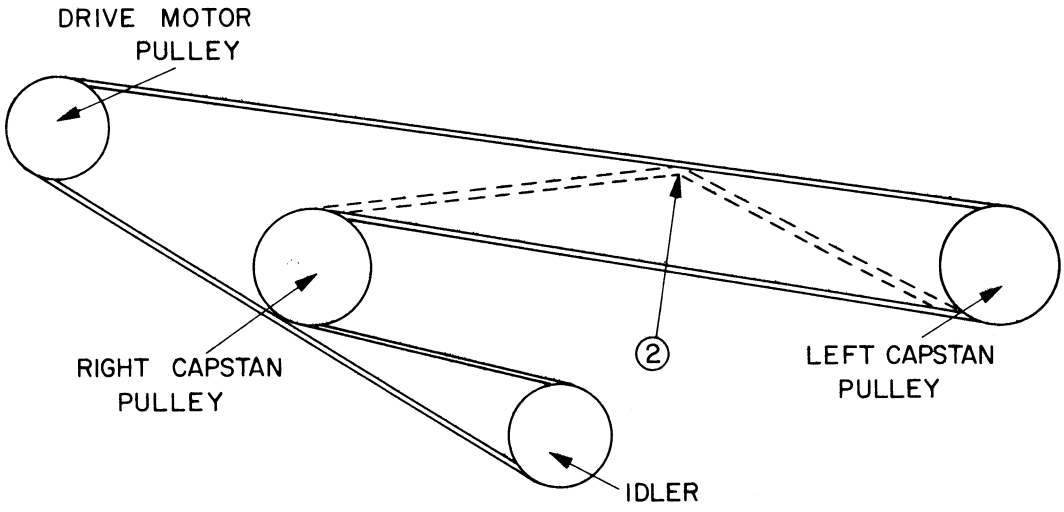
FIGURE: 21



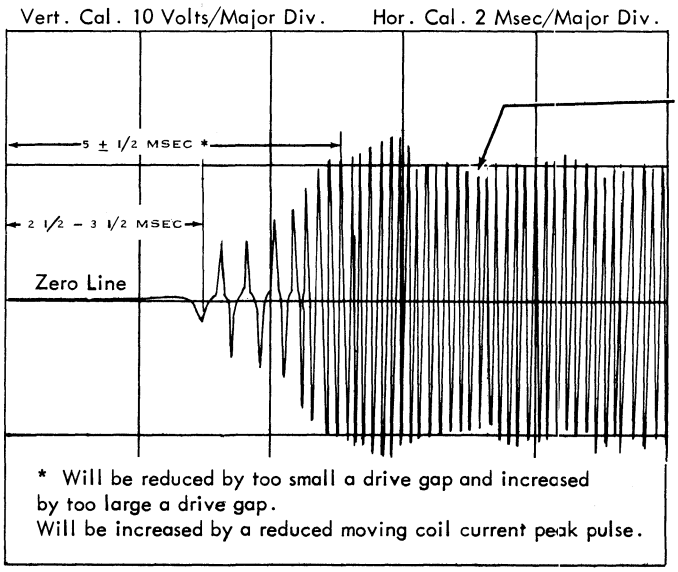
VACUUM COLUMN ADJUSTMENT

FIGURE 22





CAPSTAN DRIVE BELT TENSION
FIGURE 23
(REAR VIEWS)



Signal Reduction due to
a. A small non-drive gap; having a tendency to drive tape at both capstans.
b. Worn pin in capstan drive pulley.
c. Pressure pad adjustment.
Keep this reduction at a minimum
The signal level should be stable by 7-1/2 msec.

FIGURE 24. START ENVELOPE

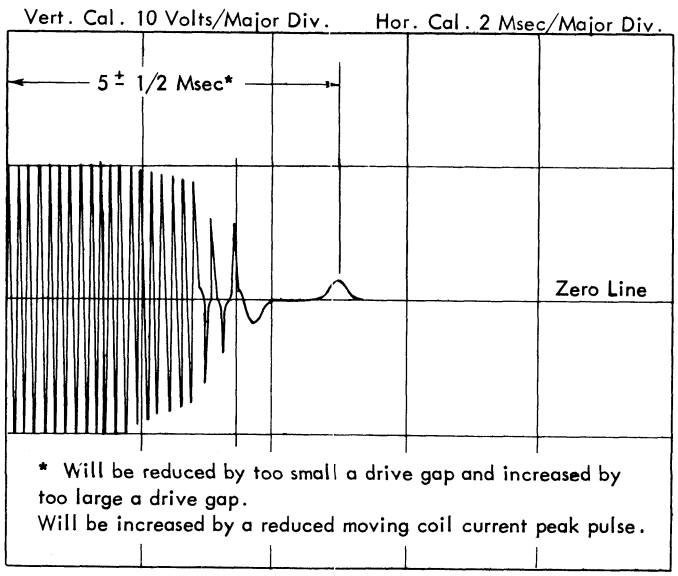


FIGURE 25. STOP ENVELOPE

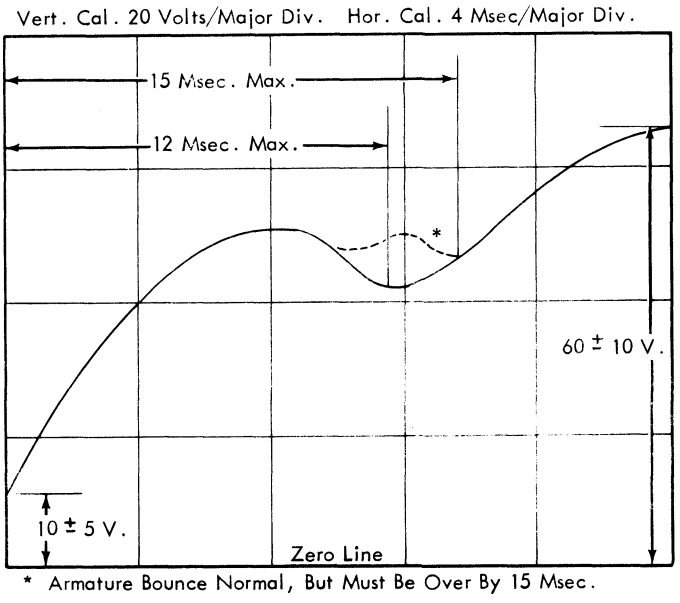


FIGURE 26. REVERSE MAGNET TRANSFER

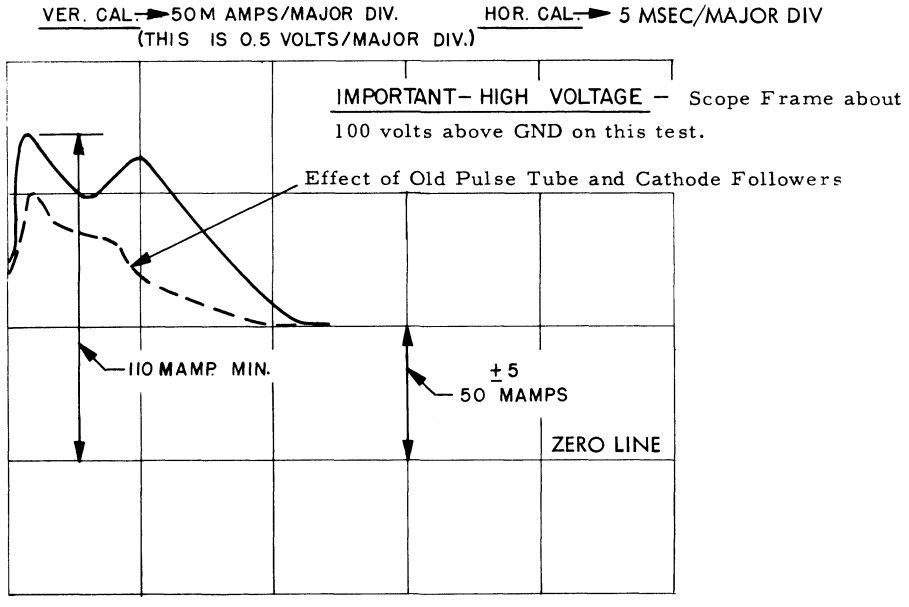


FIGURE 27. MOVING COIL WAVE FORM

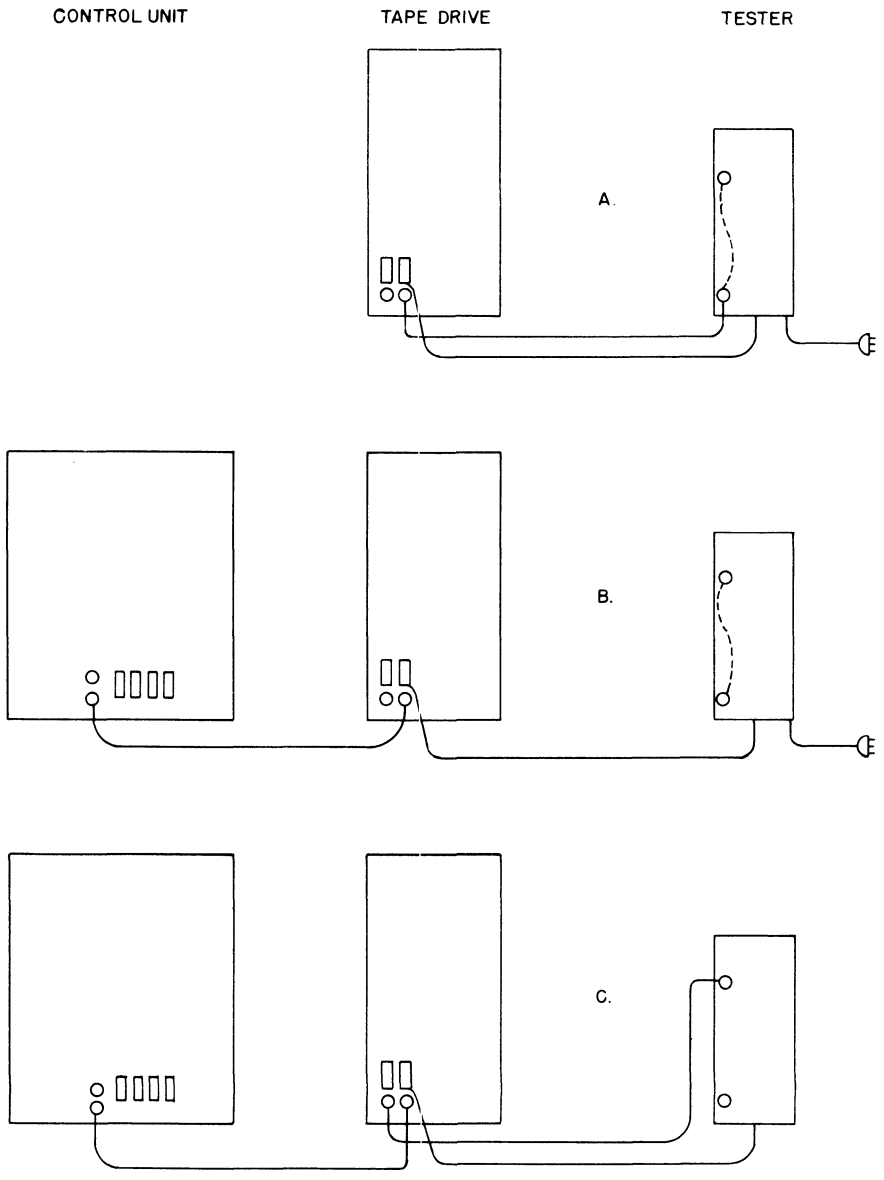


FIGURE 28. TAPE DRIVE TESTER CONNECTIONS

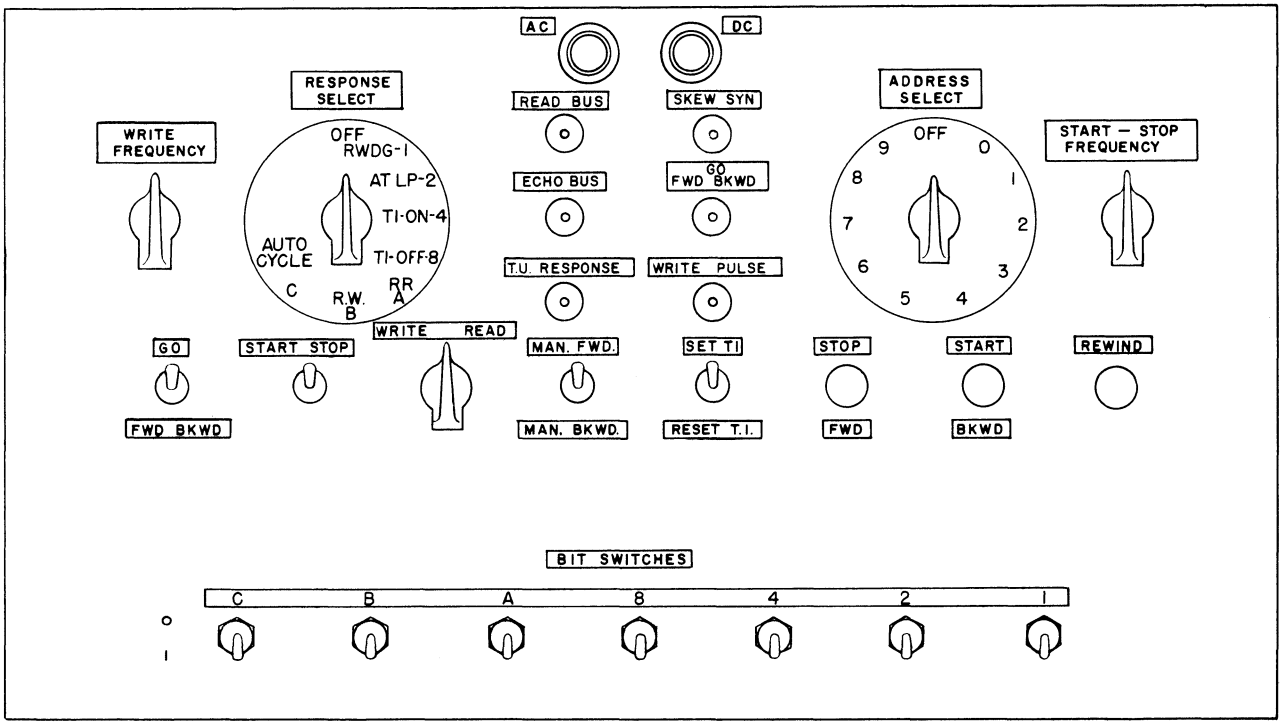


FIGURE 29. 727 TAPE DRIVE TESTER

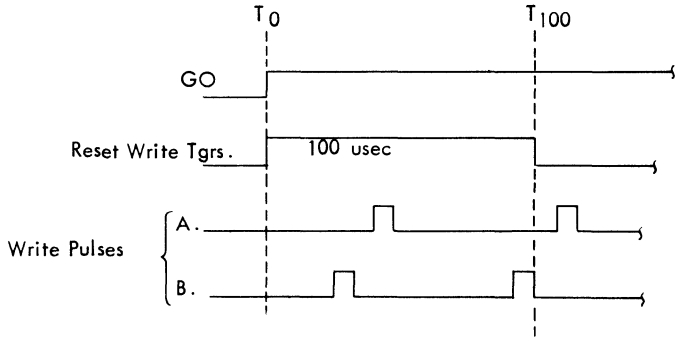
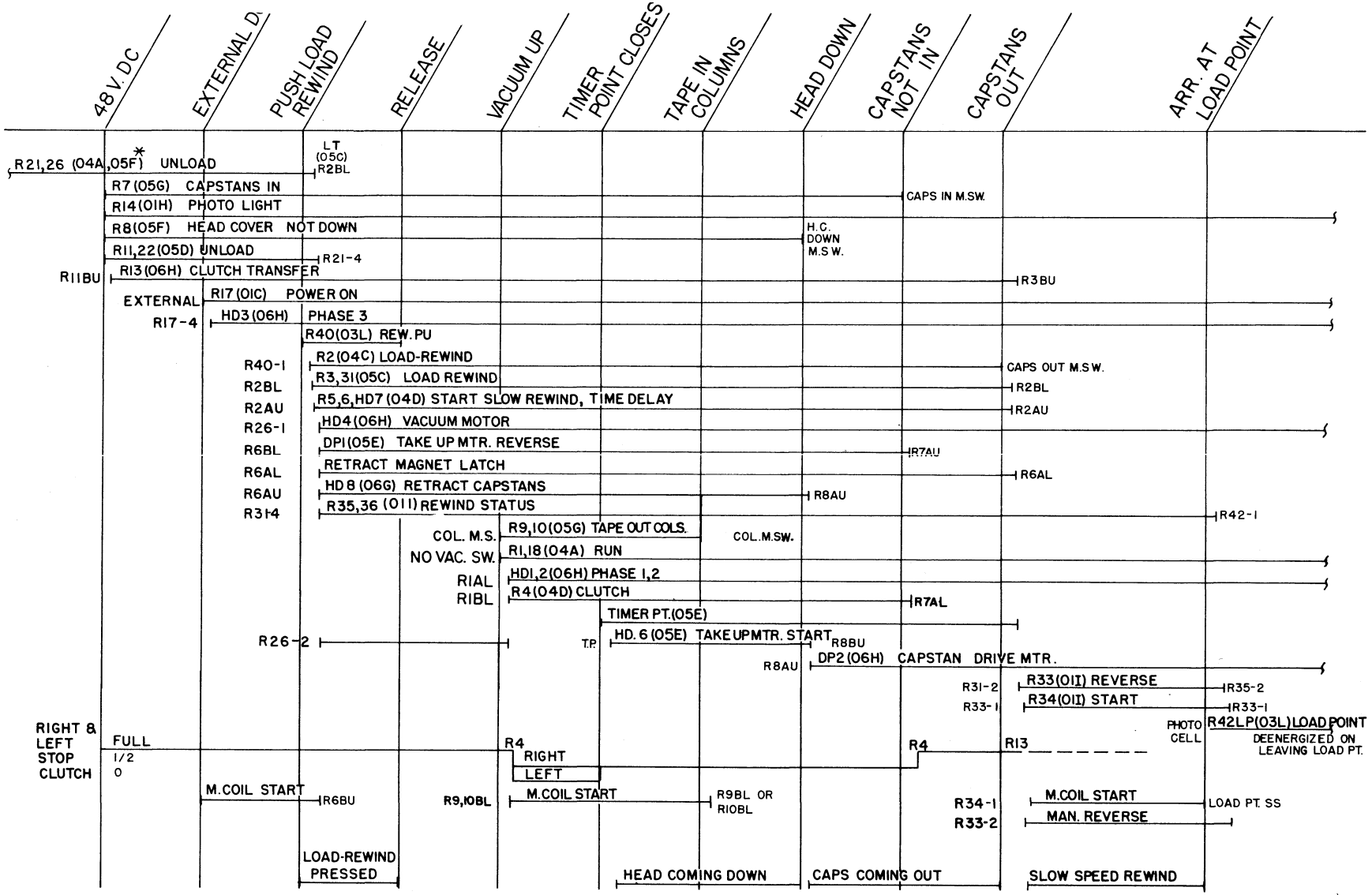


FIGURE 30. TAPE TESTER - RESET WRITE TRIGGERS



* LOCATIONS IN SYSTEMS DIAGRAM PAGE 75.09.XX. OR IN FANFOLD DIAGRAM SECTION 18.0

FIGURE 31

LOW SPEED REWIND

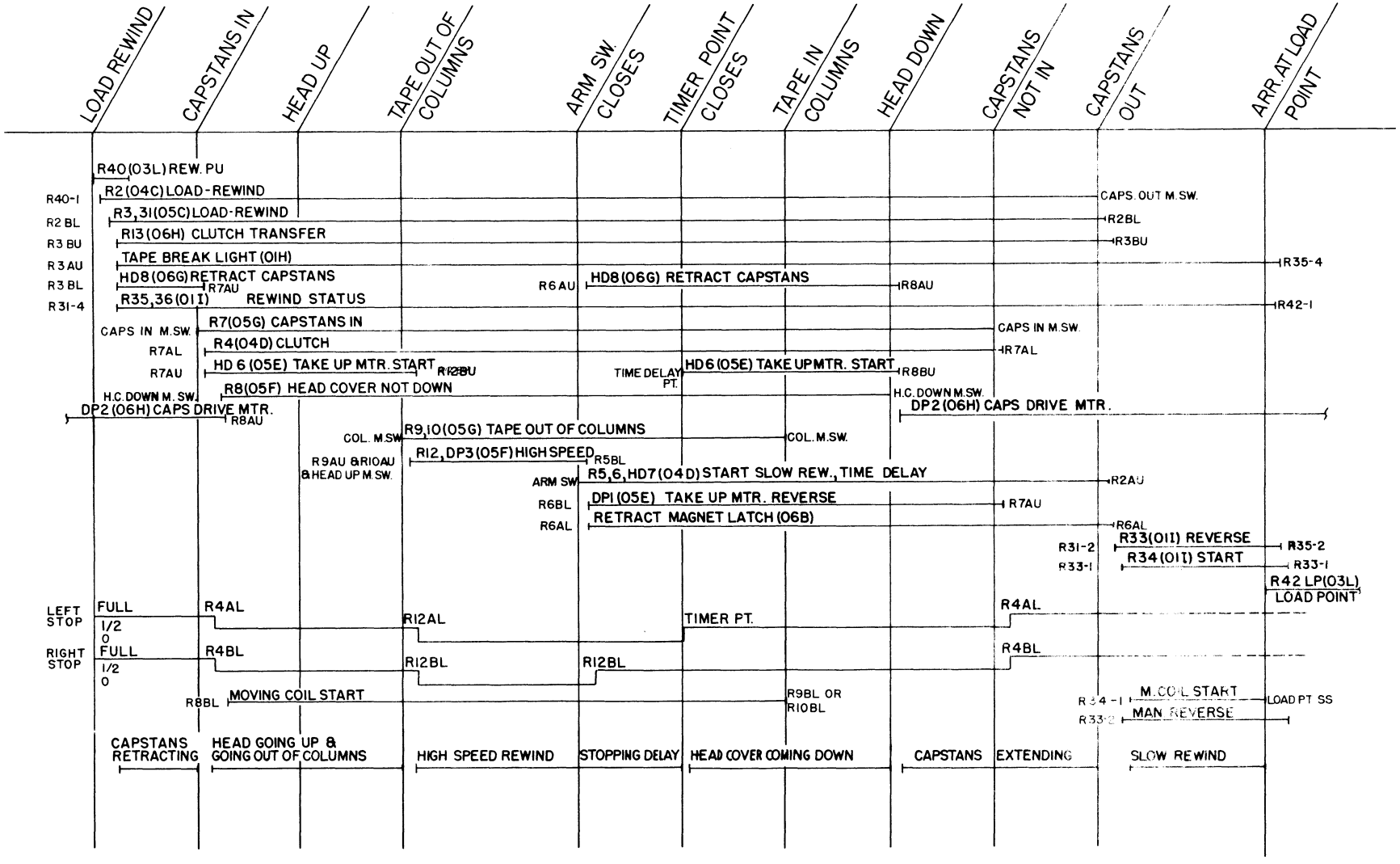


FIGURE 32

HIGH SPEED REWIND

727 MODEL III TAPE DRIVE

22.0 INTRODUCTION

22.1 MECHANICAL PRINCIPLES

The differences between the Model I 727 and the Model II 727 are minor, consisting only of cover changes. The Model III changes are described in this appendix; the mechanical changes are described in this section.

The magnetic-clutch mounting assembly on Models I and II tape drive is built of fabricated steel plate. On the Model III, the clutches are mounted on a single casting. Preloaded bearings are now used in the magnetic clutches to eliminate axial travel (end play) between the clutch rotor and housing.

The capstan drive motor, belt, and retracting mechanism have been replaced by two individual capstan drive motors. These motors are 1/20 HP, 60 cycle, 3 phase, 208 volt, reluctance synchronous motors (Figure 33).

The capstans and rotor are attached directly to the motor shaft. The shaft is fitted to have 13/16-inch axial travel within the motor housing. The complete assembly is spring loaded to hold the capstan in a retracted position when no power is applied to the motor. When power is applied to the motor, the rotor is pulled forward; it aligns itself between the field coils. This causes the drive capstans to come out into drive position automatically at any time the motor is running. Sensing switches on each drive sense whether the capstans are in or out.

The sensing switches are magnetically operated (Figure 34). When the motor is not running, the rotor shaft is forced into a retracted position by the capstan retracting spring. The steel disc mounted on the read end of the motor shaft is then close to the permanent magnet that is mounted on the capstan-in switch operating arm. The magnet is attracted to the steel disc causing the microswitch to be operated. When power is applied to the motor, the steel disc is moved forward with the motor shaft, allowing the capstan-in switch to return to normal. The capstan-out switch operates when the disc has moved near to the permanent magnet attached to its operating lever.

The fabricated steel vacuum columns on Models I and II are replaced by extruded aluminum columns on the Model III. The plastic front plates on the vacuum columns are replaced with glass plates. These glass plates present a harder wearing surface to the tape and prevent the tape from cutting the plates near the areas where the limit switches are located.

Mercury switches are now used on the manifold flapper valves for sensing instead of microswitches. They eliminate marginal adjustment conditions that were present when the previous type switch was used.

One other mechanical change is that one blower has been omitted from the tube gate.

22.2 ELECTRONIC CIRCUITS

Logically, the electronic systems for the Model III are the same as for Models I and II. Some circuits have been omitted. They were directly concerned with relays that have been omitted. The changes are as follows:

727 Models I and II	Model III	Change (Omissions on the Model III Systems)
75.03	76.03	AND circuit E32F, which AND'ed "rewind interlock status" with photo-cell output to relay driver T05J7B to pick tape break relay. Reason for this omission is that the tape break relay has been omitted.
75.04	76.04	Cathode follower T04J6F and OR circuit F23F. These circuits were used to drop L.P. relay when the unload relay was picked. In the Model III, the L.P. relay is dropped because "AT L.P." AND's with "start" on 76.04.
75.08	76.08	Cathode follower T03J8F. T03J8 powered rewind interlock line out to "tape break gate" (page 75.03). Tape break relay has been omitted.

23.0 RELAY CIRCUITS

23.1 LOAD, IN LOW-SPEED REWIND AREA

This is the relay operation sequence for a load operation when less than one-half inch of tape is wound on the right-hand reel. The machine is in the following condition before the load-rewind button is depressed.

1. Both reels are on machine with enough tape threaded across to the right reel to have the load point reflective spot on that reel.
2. Full brake on both reels.
3. 48-volt supply available.
4. Door closed.
5. Relays and switches as shown in Figure 35.

When the load-rewind button is depressed, +48 volts is applied to cathode follower T03J2B (76.08) "Manual Load Rewind." This results in an up level from the cathode follower, conditioning the lower leg of AND circuit T03JB30F (76.08). The upper leg is up because "read status" is up. Therefore, the up level from AND circuit B30F carries through OR circuit T03JA32F and cathode follower T03J3B, conditioning relay driver T03J4B to pick R21. Relay 21 points latch trip relay 15 and 16 to take the tape drive out of unload status. The tape break light goes out because R10 drops. HD4 picks and starts the vacuum motor running. DP1 point changes the power phases to the take-up motor so that it runs in reverse when DP4 completes the circuit later in the sequence. Relay 8 completes the circuit to the timer motor and the timer starts.

Next in the sequence, the vacuum motor pumps enough air to operate the column (flapper) switches. The flappers partially seal off the manifold so that enough vacuum builds up to operate the bellows switch.

The normally open bellows switch points close to pick R1, HD1, HD2, and HD3 at this time. Relay 1 points change the status of right and left brakes from full brake to one-half brake. HD1, HD2 and HD3 furnish circuits for all three phases to the motors and the reel motors start.

Next in sequence, the timer switch points open dropping R27. The R27-2n/c points furnish a pick curcuit to DP4. DP4 points complete the circuit to the take-up motor which had previously been conditioned to run in a reverse direction.

The take-up motor starts driving the head down and rotating both reels feeding tape into the columns. As the tape seals off the columns tightly, the flappers are allowed to open again. The head-down microswitch operates dropping R2 and R28.

Relay 2AUn/c point completes a circuit to pick DP2. DP2 A and B points close allowing the capstan drive motors to start. The capstan-out switches sense that both capstans are out and drop R3. Dropping relay 3 drops R9; R9-3n/c points close to pick R27 and supply +48v to the manual reverse line. Relay 27-1n/o points close to furnish +48 to the manual start line and the tape is now driven backward.

The load-point reflective spot is sensed and R25 picks. Relay 25-3n/c points open, dropping R12. Relay 12-1n/o points open, dropping +48 volts to manual reverse and manual start. This causes the tape drive to stop setting in a loaded condition.

23.2 MANUAL CONTROL OF TAPE MOTION

The following section deals with the manual control of tape motion, using the customer engineer's switch and the load-rewind button.

With the C.E. switch set to FORWARD GO, +48 volts is available to pick R27 from R12-5n/c, R1AUn/o, R13-1n/c, C.E. switch, R6ALn/c, R5ALn/c, R15-4n/c, to the R27 coil. In this case, +48 volts is blocked from "manual reverse" by diode D5. Relay 27-1n/o closes to bring up the manual start line. The up level on manual start conditions the top leg of AND circuit T03JF27F (76.05.01). The bottom leg is conditioned by "not arriving at load point." The resulting up level from F27F carries through OR circuit T03JE29F and brings down the stop line through inverter T03J7B. Tape starts feeding in a forward direction at this time.

The plus shift on the start line is also fed to the bottom leg of AND circuit T04JG20F (76.04). An up level results from G20F because the top leg is conditioned by "At L.P." This up level causes relay driver T04J5B to pick relay 26. Relay 26-1n/o closes to furnish +48 volts to the R25 latch trip coil.

Relay 25 returns to normal and the R25-4n/o points open to bring down "At L.P." to AND circuit G20F (76.04). This results in a down level to the relay driver T04J5B, allowing R26 to fall.

With the C.E. switch set to stop, R27 is allowed to fall. This brings down the manual start line and the tape is stopped.

With the C.E. switch set to BACKWARD GO, +48 volts is applied to the manual reverse line through the 25-1n/c and the 9-3n/c points. Relay 27 is picked through the diode D5, R6ALn/c, R5ALn/c, and R15-4n/c points. Conditioning the manual reverse line causes the tape to drive backward, from the right reel to the left reel. Turning the C.E. switch to stop brings down "manual reverse" and "manual start", causing the tape to stop again.

Depressing the load rewind button conditions the lower leg of AND circuit T03JB30F (76.08). The top leg is conditioned by read status and the resulting up level causes relay 21 to be picked by relay driver T03J4B. Relay 21-1n/o points close to pick R3 and R3BUn/o closes to pick R9. Relay 12 is picked because of the R9-5n/o points closing and it is held by the R12-2n/o points through diode D2. The load point reflective spot being read causes R25 to be latch picked, R25-3n/c opens to drop R12. Relay 12-1n/o opens to drop R27 and +48 to the manual reverse line. The tape drive stops, setting in loaded condition with the load-point reflective spot under the photo cell.

23.3 TAPE MOTION UNDER CALCULATOR CONTROL

Tape motion can be controlled from the computer programming. A control 0002 instruction in the 705 CPU causes the start rewind line to condition the upper

leg of AND circuit T03JC3F (76.08). Select and ready conditions the lower leg. The resulting up level conditions the relay driver T03J4B; R21 is picked. If R21 is picked when less than one-half inch of tape is on the right reel, a slow-speed rewind operation results (Figure 36). Picking R21 with more than one-half inch of tape on the right reel causes a high-speed rewind operation (Figure 37).

23.4 HIGH-SPEED REWIND

This operation starts with the tape drive in the following condition. Enough tape is wound on the right-hand reel to operate the arm switch; the drive is in a stop status. When the load-rewind button is depressed, relays 2, 9, 12, 21, and 28 pick up. DP2 drops, breaking the circuit to the capstan drive motors. DP3 starts the rewind motor when the capstans are retracted, the head is up, and tape is out of the columns. Tape is wound from the right-hand reel to the left-hand reel at high speed until the art switch makes. At this time DP3 drops the circuit to the rewind motor and one-half brake is applied to the right-hand reel. Relay 8 starts the timer motor; five seconds later the timer points transfer. This delay period allows the reels to coast to a stop. After the reels have stopped, the head comes back down, tape enters the columns, the capstans come out and tape is driven backward to the load point.

23.5 UNLOAD

Starting with tape setting at load point, depressing the unload button results in the following sequence (Figure 38). The unload button latch picks R15 and R15-2 n/o closes to pick R10. Relays 2 and 28 are picked. Relay 2AUn/c transfers, dropping DP2 which opens the circuit to the capstan drive motors so that the capstans retract. Relay 2 points also cause one-half brake to be applied to both the right- and left-hand reels.

The capstan in microswitches operate when the capstans are fully retracted, causing R27 to be picked. Relay 27-1n/o closes to bring up "manual start" and this up level AND's with "At Load Point" in AND circuit T04JG20F (76.04). The resulting up level conditions relay driver T04J5B, causing R26 to be picked. Relay 26-1n/o closes and completes a circuit to the R25 latch trip coil. Relay 25-4n/o opens dropping the "At L.P." to AND circuit T04JG20F and the resulting down level allows R26 to fall.

DP4 also picks as a result of the capstan-in switches' closing. Therefore, the take-up motor starts to bring up the read-write head. As the head-up microswitch senses that the head is fully raised and the flappers move to operate the column switches, R16 (unload stop) is latch picked. HD4 falls as a result of the transfer of R16-1n/o; the HD4 points break the circuit to the vacuum motor. Vacuum falls. Then the bellows switch senses loss of vacuum and its points transfer allowing HD1, 2, 3, and R1 to drop. Relay 1 points effect a change from half brake to full brake and the drive now sets in an unloaded condition.

24.0 PURPOSE OF RELAY POINTS

R1, Run Relay (76.09.01)	Picked when the bellows switch closes. Senses failures such as fuse bail operation, loss of vacuum in either column, photocell bulb failure, or bellows switch operation during a normal operation.
1AU (76.09.07)	Completes circuit for +48 volts to the C.E. switch and ready line. Drops "ready" in case of any of the above named failures.
1AL (76.09.08)	Drops R13 (start) for any of the above named failures.
1BU (76.10.01)	Applies full brake to the left-hand reel when normal. N/O points complete a circuit to the R2AL points when R1 is energized.
1BL (76.10.01)	Same usage as R1BU but applied to the right reel.
R2, Clutch status relay 1 (76.09.08)	Picks up during rewind and load operations. When energized, it allows a circuit to be completed for half brake on both reels. R2 points also control the energization of the capstan drive motors.
2AU (76.09.06)	N/C points pick DP2 so that the capstan motors are running only when R2 is down. N/O points energize the head lock solenoid so that the head will be unlocked and free for movement during load-rewind operations.
2BU (76.10.01)	Places tape motion under control of the left vacuum column switches during normal operation.
2BU (76.10.01)	Places tape motion under control of the right vacuum column switches during normal operation.
R3, Load rewind 1 relay (76.09.04)	Picks during load-rewind operations.
3AU (76.09.08)	Picks R8 to start time delay in slow-speed rewind operation.
3AL (76.09.08)	Picks arm switch relay 4 and take-up motor reverse relay DP1 in load-rewind operation.
3BU (76.09.05)	Picks R9 (load-rewind 2) any time R3 is picked.
3BL (76.09.08)	Holds R2 and R28 when R15 is latch tripped at start of a load-rewind operation in a slow-speed area.
R4, Arm switch relay (76.08.08)	Picks during load-rewind operations when less than one-half inch of tape is wound on the right-hand reel.
4AU (76.09.08)	Picks R8 (time delay motor start) when entering low-speed rewind area from high-speed rewind.
4AL (76.09.02)	Completes a pick circuit for DP4 to start the take-up motor while R27 is up, starting a high-speed rewind operation.
4BL (76.09.08)	Holds R4 and DP1 when entering low-speed rewind area from high-speed rewind area so arm bounce will have no effect on R4 and DP1.
R5, Flapper switch relay (76.09.06)	Picks when the flapper valve switch left, is operated.

5AU (76.09.01)	Drops relay 1 (run) if tape is not in the left column during normal operation.
5AL (76.09.02)	Drops R27 (GO status) if tape is not in left column during normal operation.
5BU (76.09.09)	Interlock on pick of R23 (high-speed rewind status). Tape must be out of left column before entering high-speed rewind.
R6, Flapper switch relay (76.09.06)	Picks when the right flapper-valve switch is operated.
6AU (76.09.01)	Drops relay 1 (run) if tape is not in the right column during normal operation.
6AL (76.09.02)	Drops R27 (GO status) if tape is not in the right column during a normal operation.
6BU (76.09.09)	Interlock on pick of R23 (high-speed rewind status). Tape must be out of right column before entering high-speed rewind status.
R7, Photo light relay (76.09.03)	Picked through the tape break, load point, TI lamps when +48 volts is up. Drops as a result of a failure of any of the lamp filaments.
7AL (76.09.01)	Drops R1, HD1, 2 and 3 with a photo light failure.
7BL (76.09.05)	Interlocks picking R21 (rewind PU) when a photo light has failed.
R8, Time-delay motor relay (76.09.08)	Picks during rewind operations to start the time delay motor.
8AU (76.10.02)	Completes a circuit from phase 1 through the timer motor to phase 2.
8BU (76.09.09)	Interlocks picking R23 (high-speed rewind) while timer is running and drops R23 when timer starts.
R9, Load-rewind 2 (76.09.05)	Picks at any time R3 is picked.
9-1 (76.09.01)	Parallels R5AU and R6AU to pick R1, HD1, 2, and 3 during a load-rewind operation.
9-2 (76.09.08)	Allows R13 to be picked before bellows switch operates.
9-3 (76.09.02)	Completes a circuit to manual reverse and R27 during rewind operations.
9-4 (76.09.04)	Hold circuit for R3 during load-rewind operations.
9-5 (76.09.08)	Picks R12 (rewind status) during load-rewind operations.
9-6 (76.09.07)	Drops "not file protect" to 76.02. Makes it impossible to have write status during a load-rewind operation.
R10, Unload 2 (76.04.04)	Picked when the tape drive is in an unload status.
10-3 (76.09.09)	Causes the tape break lamp to come on when unload is depressed.
10-4 (76.09.09)	Causes R16 to be latch picked when the tape is out of the columns on unload.
10-5 (76.09.03)	Drops the parallel resistance circuit around the R7 coil causing the photo cell lamps to dim when the drive is unloaded.

10-6 (76.09.07)	Drops "not file protect" to 76.02. Keeps write status down when drive is in unload status.
R12, Rewind status (76.09.08)	Picks when the load-rewind button is depressed.
12-1 (76.09.02)	Supplies a circuit for +48 volts to the 9-3 points so R27 can pick and the manual-reverse line can be powered.
12-2 (76.09.08)	Supplies a hold circuit for R12.
12-3 (76.09.07)	Furnishes a shift to set the R/W trigger to read status in a high-speed rewind operation.
12-4 (76.09.07)	Keeps "not file protect" down during rewind operations.
12-5 (76.09.07)	Drops "mechanically ready" to 76.01 and brings up "rewind status" to 76.08. "Rewind status" AND's with select bringing up "select and rewind status" to the tape control unit.
R13, Start relay (76.09.08)	Picks when the start button is depressed and holds until reset is depressed.
13-1 (76.09.02)	Breaks the circuit to the C.E. switch when the tape drive is in use with the CPU or other I/O machines.
13-2 (76.09.08)	Hold point for R13.
13-3 (76.09.07)	Drops "relay reset" to 76.02 so that the R/W triggers can be operated.
13-4 (76.09.04)	Opens the circuit to the load-rewind switch when the tape drive is in use with CPU or card machines until reset is depressed.
13-5 (76.09.07)	Brings up "mechanically ready" to power the ready light and the lower leg of AND circuit to 6JA12F (76.01).
13-6 (76.09.09)	Opens the circuit from the unload switch to the latch pick coil of R15 for unload. Cannot unload without hitting the reset button first.
R15, Unload I (76.09.09) Latch pick and latch trip	Latch picks when the unload button is depressed. Latch trips when R21 is picked for a load-rewind operation.
15-1 (76.09.01)	Parallels R5AU, R6AU, and R7AL to hold R1, HD1, HD2, and HD3 during an unload operation.
15-2 (76.09.08)	Picks and holds R2 and R28 when the unload button is depressed.
15-3 (76.09.04)	Picks R10 (Unload II) relay.
15-4 (76.09.02)	Breaks the circuit to R27 thus dropping GO if the unload button is depressed while in manual forward or backward go operation.
R16, Unload stop (76.09.09) Latch pick and latch trip	Latch picks during an unload operation when the head is up and tape is out of both columns. Latch trips when the load-rewind button is depressed.
16-1 (76.09.04)	N/C points complete the circuit to HD4 to start vacuum motor. N/O points supply +48 volts to the 21-1 points to latch trip R16 for load rewind.
16-2 (76.09.02)	Picks DP4 to start the take-up motor in a load rewind operation.

16-3 (76.09.09)	Opens the circuit around the load-point and tape-indicator photo-cell lamps when drive is unloaded.
16-4 (76.09.06)	Drops the circuit to the head lock solenoid when the drive is unloaded.
R17, Power on reset	Picks when +48 volts is up and holds until 48 volts drops.
17-1 (76.09.01)	Drops R1, HD1, HD2, and HD3 if +48 volts drops.
17-3 (76.09.04)	Prevents picking of the R3 relay when the power is coming up.
17-4 (76.09.08)	Prevents picking R12 when power is coming up.
R21, Rewind PU (76.09.05)	Picks up from relay driver T03J4B (76.08). T03J4B is conditioned either from a call from CPU or manual load rewind operation.
21-1 (76.09.04)	Completes the circuit to pick R3 at start of any rewind operation.
21-2 (76.09.09)	Latch trips R16 to take the drive out of unload status.
21-3 (76.09.09)	Latch trips R16 to take drive out of unload status.
R23, High-speed rewind status (76.09.05)	Picks when the tape is out of both columns and the head is up at the start of a load-rewind operation.
23-1 (76.10.01)	Opens the circuit for 1/2 brake on the right reel during high-speed rewind.
23-2 (76.09.02)	Makes a circuit to pick R24 and R27 during high-speed rewind.
R24, High-speed rewind interlock (76.09.02)	Picks at any time that R23 picks.
24-1 (76.09.09)	Opens and allows the tape break light to operate during a high-speed rewind operation.
24-2 (76.10.01)	Opens the circuit for half brake on the left reel during high-speed rewind.
24-3 (76.09.02)	Keeps GO status relay (R27) up during high-speed rewind. This holds the idlers out of the tape path.
24-5 (76.09.02)	Opens the circuit to pick DP4 during high-speed rewind.
R25, Load point relay (76.09.05) Latch pick (76.09.03) Latch trip	Latch picks when the tape has reached load point during load rewind. Latch trips when tape moves off load point.
25-1 (76.09.02)	Disables manual backward control if the tape is setting at load point.
25-2 (76.09.04)	Opens the circuit to pick R3 if tape is setting at load point.
25-3 (76.09.08)	Drops R12 (rewind status) when load point is reached.
25-4 (76.09.03)	Brings "At load point" up to (76.04). "At load point" AND's with "start" to pick R26 and goes through OR circuit C12F to AND with "select" to bring up "sel & at load point."
R26, Load point trip (76.09.05)	Picks when "start" comes up if the tape is setting at load point.
26-1 (76.09.03)	Completes a circuit to latch trip R25 when tape moves off load point.

R27, GO status (76.09.02)	Picks at any time tape is to be fed by the drive capstans.
27-1 (76.09.03)	Brings up "manual start."
DP1, Take-up motor reverse (76.09.08)	Picks during load-rewind and high-speed rewind operations.
DP1 A & B (76.10.02)	Switches two phases to the take-up motor allowing it to run in reverse.
DC fuse bail switches (76.09.01)	Points are normally as shown on 76.09.01. When the fuse bail is moved by a fuse plunger, the points transfer.
Door interlock switch (76.09.01)	The points are shown with the door open. When the door is closed, the points transfer to supply +48 to R1, HD1, HD2, and HD3.
Bellows switch (76.09.01)	Points close when vacuum is up.
Right and left capstan-in switches (76.09.02)	The shown points are normally open contacts of micro-switches. When the capstans are in, the contacts are closed.
Time delay switch (76.09.02)	Points open five seconds after the timer motor starts.
C.E. switch (76.09.02)	Manually operated single-pole, three-position switch. When the switch is set to forward go, R27 is picked. When it is set to backward go, R27 and the manual reverse line comes up.
Left and right capstan out switches (76.09.04)	The shown points are normally closed points of micro-switches. When the capstans are out, the points are open.
Flapper switches right and left (76.09.06)	The flapper switches are mercury switches. When vacuum is up and tape is out of the columns, the shown points are closed.
Unload switch (76.09.06)	Manually operated push button. Furnishes a circuit to latch pick R15.
Load-rewind switch (76.09.06)	Manually operated push button. Applies +48 volts to the manual load-rewind line which AND's with read status (76.08) causing R21 to pick.
Arm switch (76.09.08)	Operates from the arm, sensing the amount of tape on the right-hand reel. Points close when 1/2 inch of tape is on the reel.
Head-down switch (76.09.08)	Points shown are normally closed microswitch points. Open when the head is down.
Reset switch (76.09.08)	Push button switch which drops R13 when depressed.

Start push button (76.09.08)	Picks R13 when depressed.
Head-up switch (76.09.09)	The points shown are the normally open points of a micro-switch. They are closed when the head is up.

25.0 ADJUSTMENTS

25.1 CAPSTAN-IN AND CAPSTAN-OUT SENSING SWITCHES

Adjust the sensing switches with adjusting fork C (Figure 34) so that the differential of the switch (the point where switch points transfer) is centered in the fork gap. Position the sensing switches on the outboard sides to sense capstan out. Do this by pushing the capstan forward to drive position and aligning the permanent magnet position (B) with steel disc (A). The switch assembly should be set so that the magnet is attracted to the steel disc with a minimum of .010 inch gap after it is attracted. With the assembly in this position, fasten it securely to the mounting bracket. Adjust the capstan-in switches in a similar manner except that the capstan must be in its retracted position.

NOTE: To prevent marginal operation, the magnets should be attracted when about 3/8 inch of the disc is opposite the magnet.

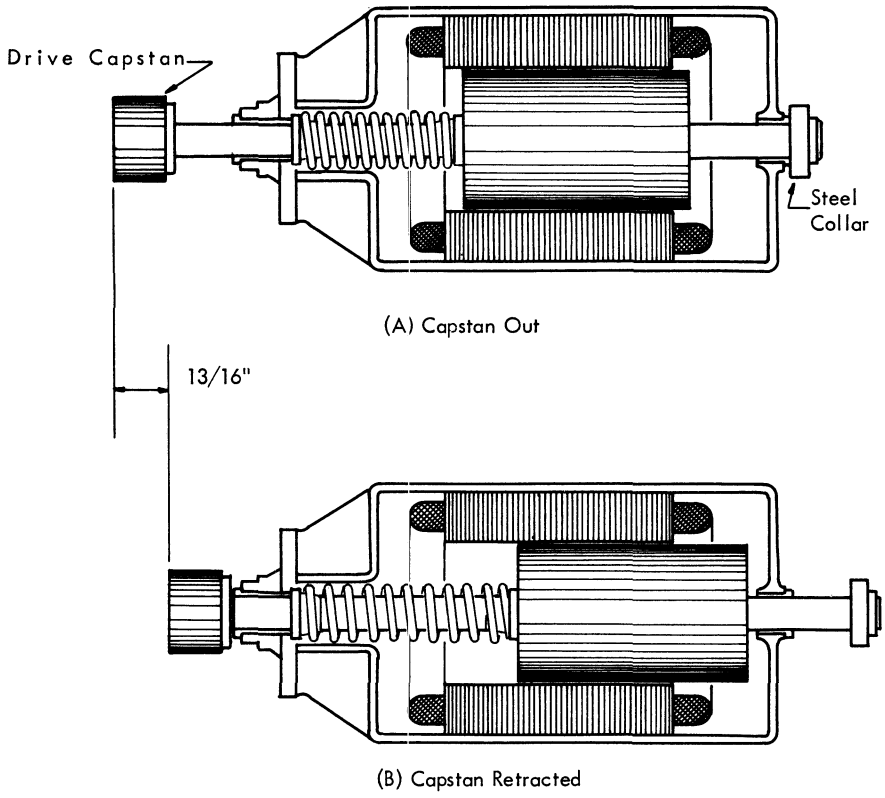


FIGURE 33. CAPSTAN DRIVE MOTOR, 727 MODEL III

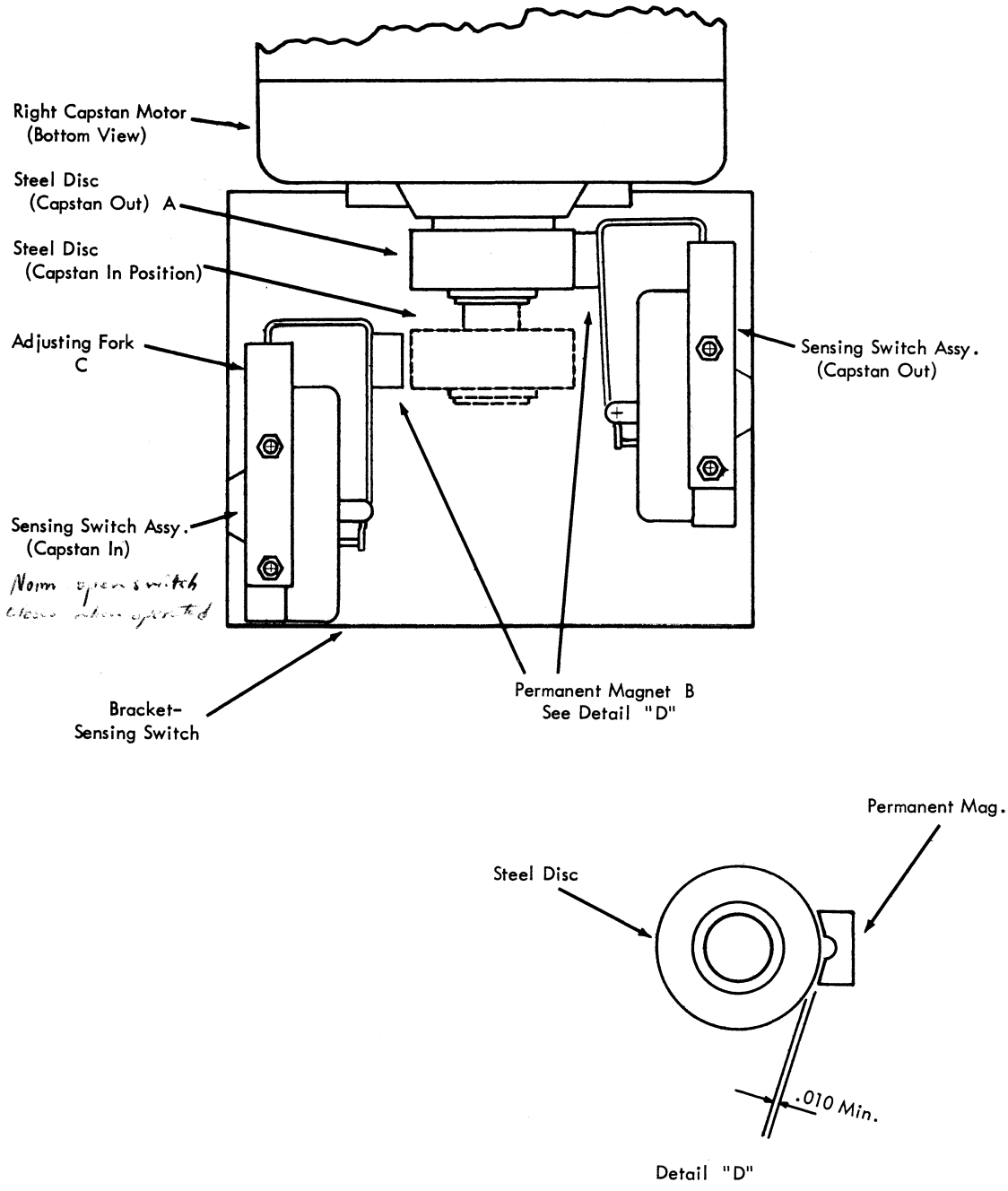


FIGURE 34. CAPSTAN SENSING SWITCHES, 727 MODEL III

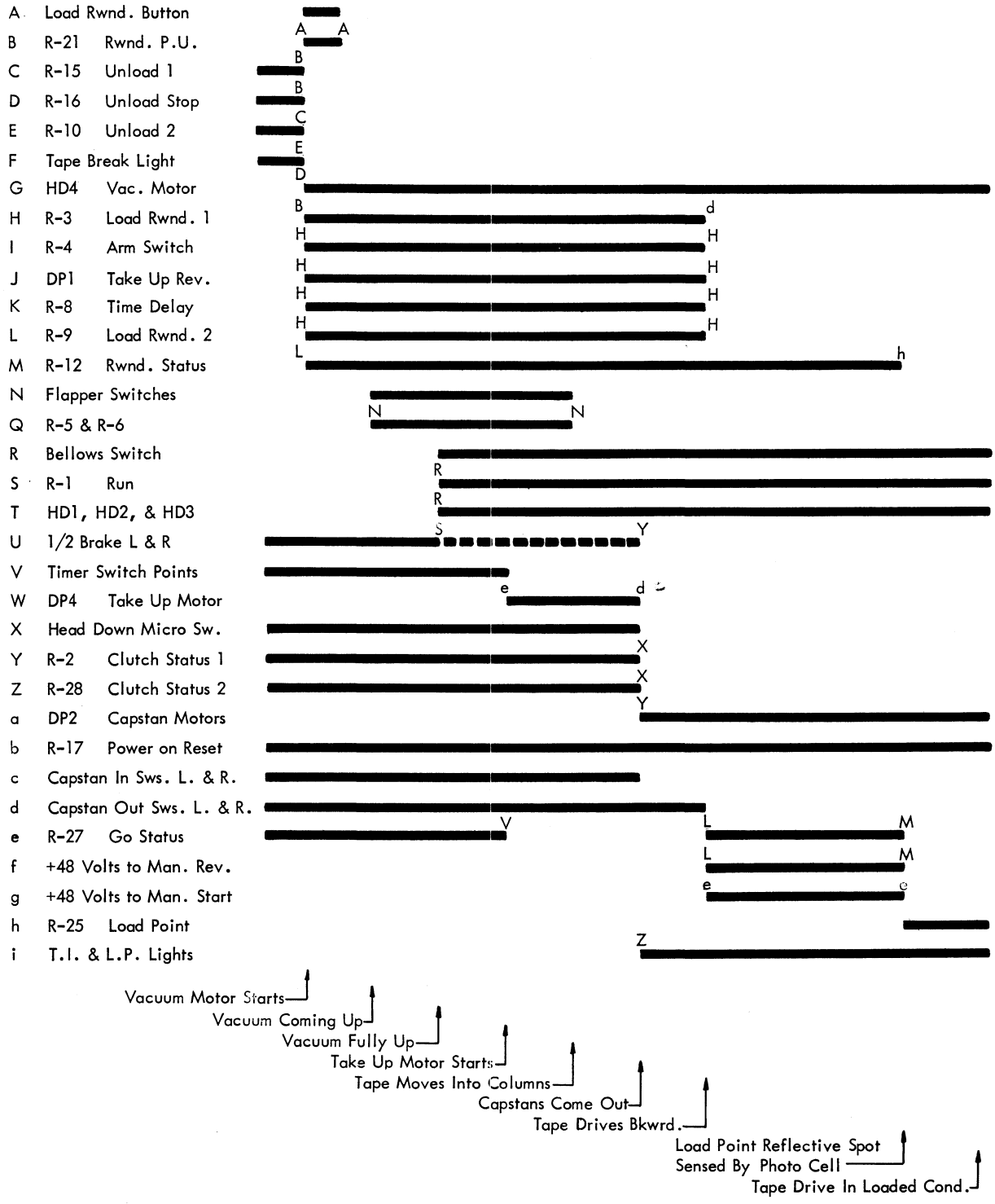


FIGURE 35. LOAD REWIND IN LOW-SPEED AREA, 727 MODEL III

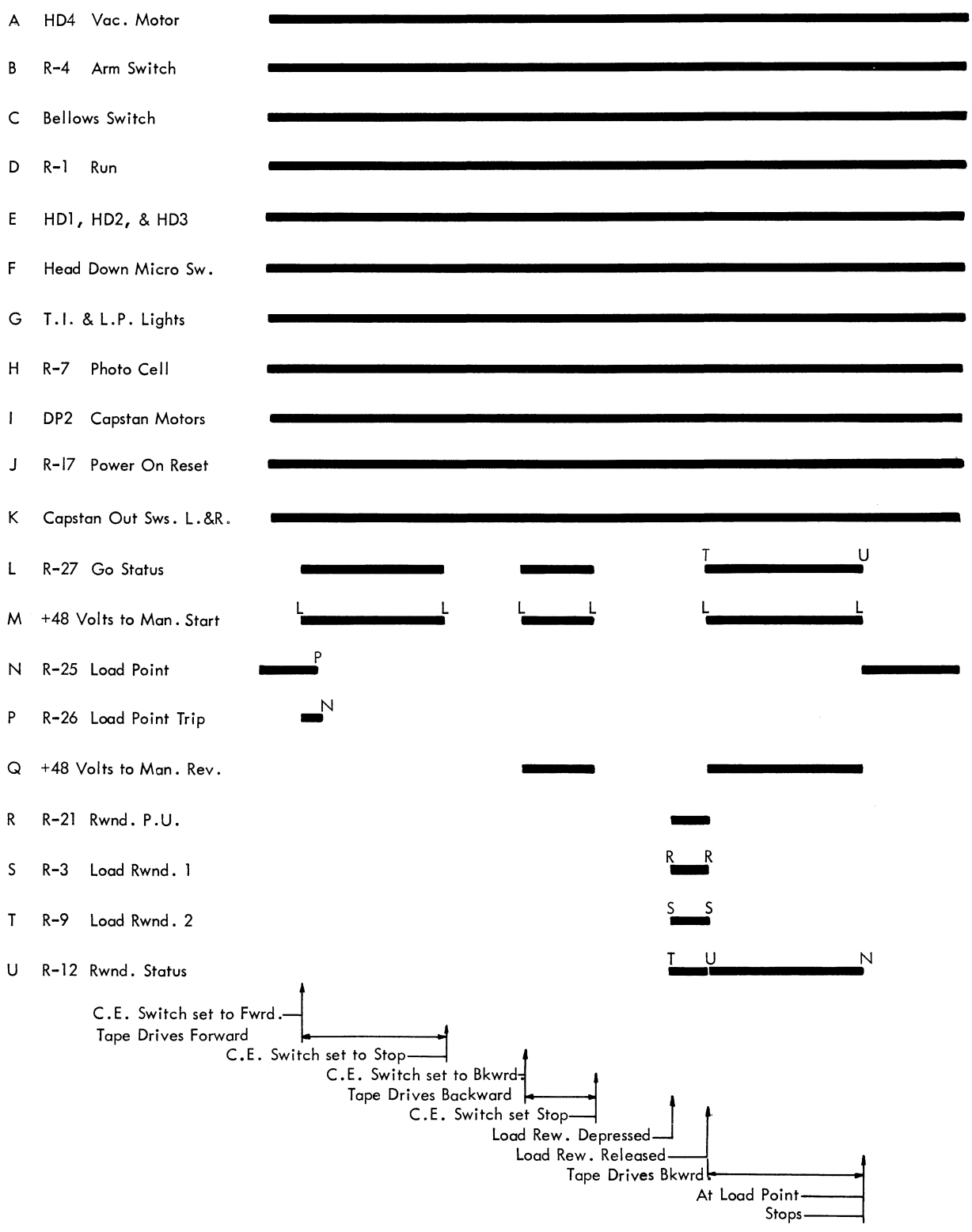


FIGURE 36. MANUAL CONTROL OF TAPE MOTION, 727 MODEL III

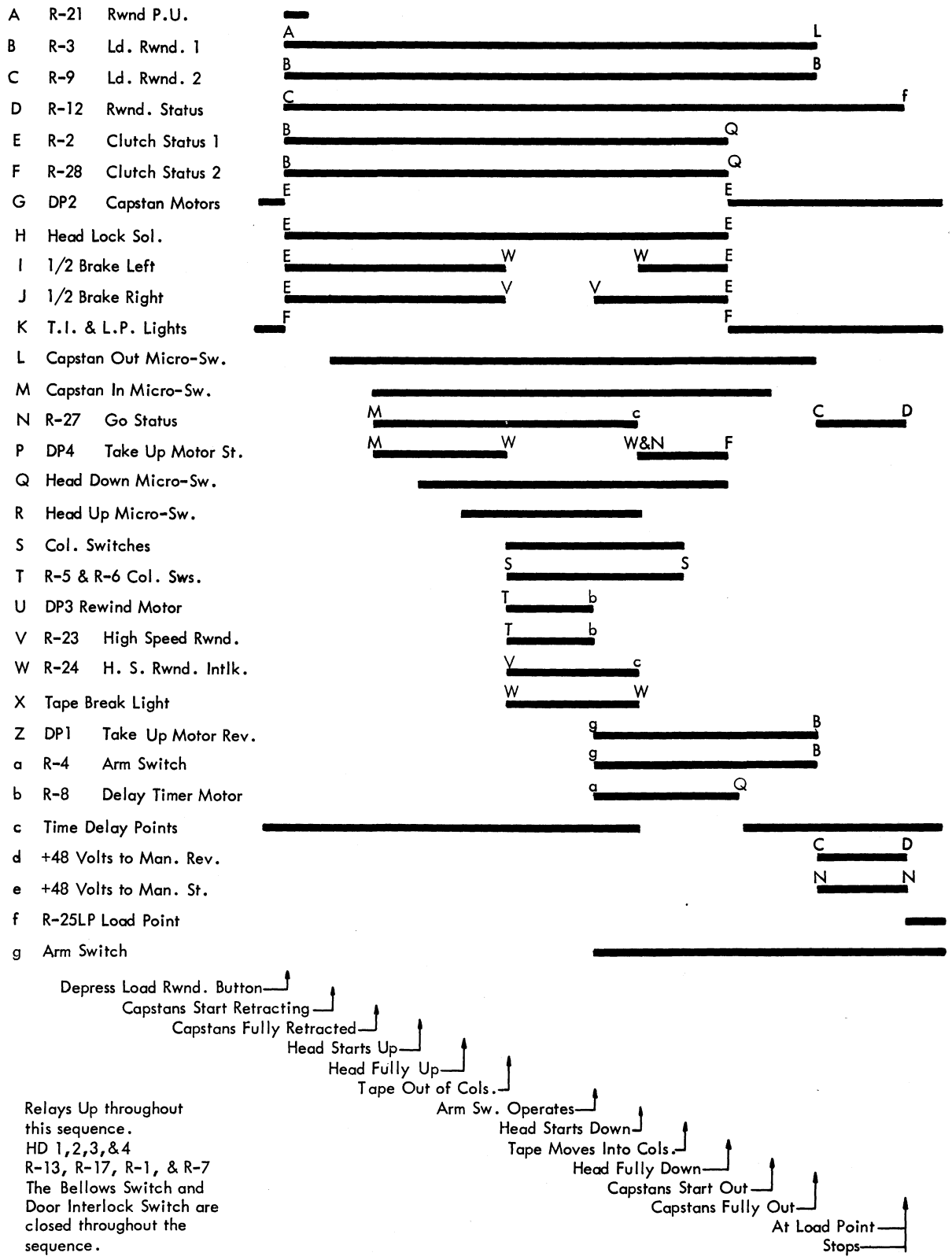


FIGURE 37. HIGH-SPEED REWIND, 727 MODEL III

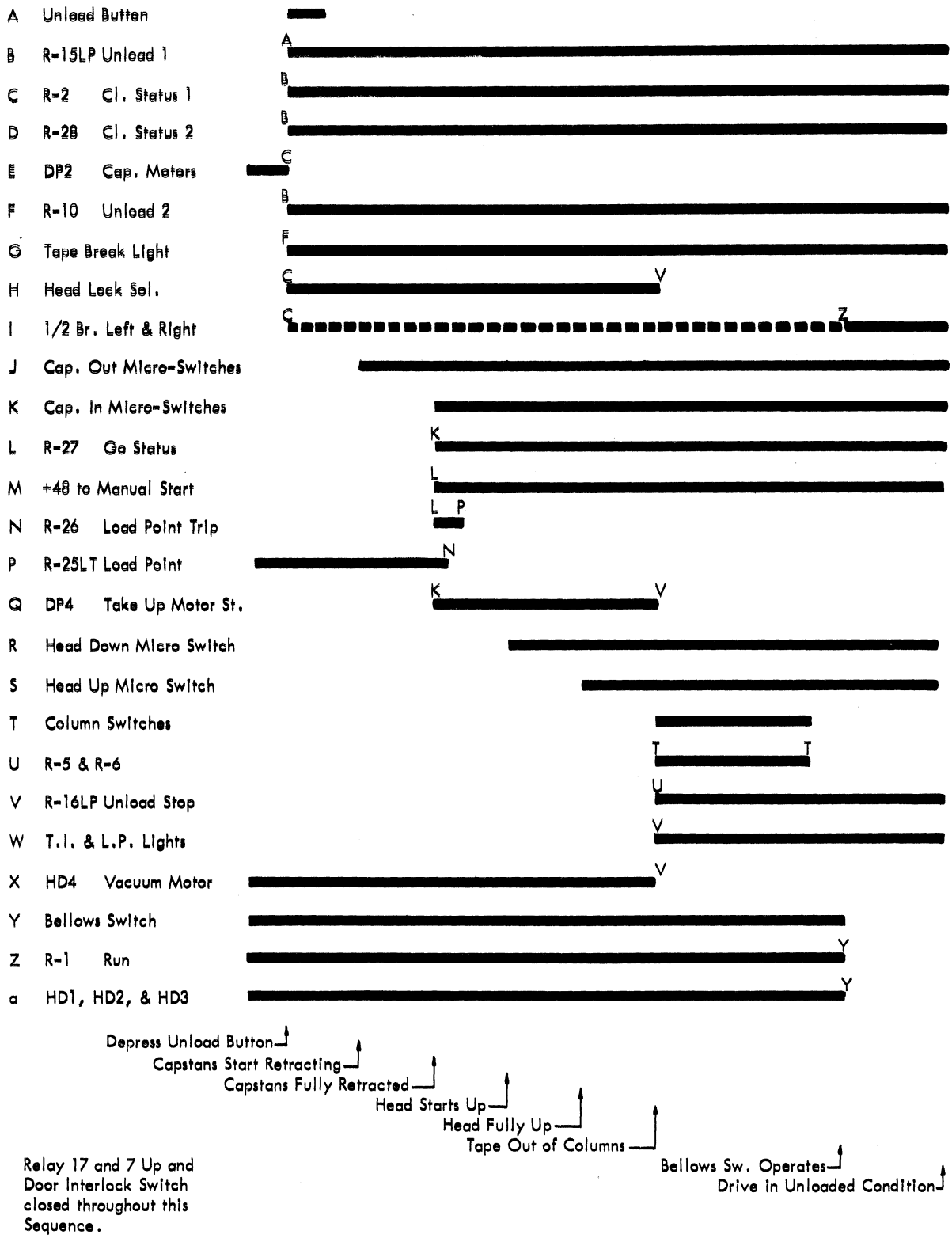


FIGURE 38. UNLOAD, 727 MODEL III

727 (Model 3) RELAY LOCATIONS

	PU	AU	AL	BU	BL
1	B1	A2	B4	01	01
2	B3	B4	01	01	
3	B4	B3	B3	B4	B3
4	B3	B3	B1		A3
5	B4	B1	B2	B2	
6	B4	A1	B2	B2	
7	A3		B1		A4
8	B3	02		B2	

	PU	LT	1	2	3	4	5	6
9	B4		B1	B3	A2	B4	A4	A2
10	B4		B2		B2	A3	A3	A2
12	B4		A2	A4	A1	A2	A2	B2
13	B4		B2	A3	A1	A2	A2	B3
15	B3	B3	B1	B3	A4	B2		
16	B2	B2	B2	B1	B3	B1		
17	A4		B1		B4	A4		
21	A4		B4	B2	B3			
22	A2		A2					
23	B2		01	B2				
24	B2		A3	01	B2		B1	
25	A4	B3	A2	B4	B4	A1		
26	A4		B3					
27	B2		A1	B1				
28	B3			A4	A3	A1		

KEYS & SWITCHES

Arm Switch	A3
Bellows Switch	B1
Capstan In Right	A1
Capstan In Left	A1
Capstan Out Right	A4
Capstan Out Left	A4
C. E. Switch	B2
Door Interlock	A1
Flapper Switch Right	B4
Flapper Switch Left	B4
Fuse Bail A. C.	A1
Fuse Bail D. C	A1
Head Down Switch	A3
Head Up Switch	B2
Load-Rewind Push Button	A2
Reset Push Button	A3
Start Push Button	A4
Time Delay Switch	B2
Unload Push Button	A3

SINGLE SHOTS - 754 TAPE CONTROL UNIT

The accompanying chart is to be used for checking our single shot timings for the 754 Tape Control Unit. The chart is set up on the assumption that the Tape Control Unit and a Tape Drive Unit will be used under manual operation, thereby eliminating the need for using CPU. The scope should be synchronized on (+) internal with the four exceptions noted on the chart as negative output, in which cases the scope should be synchronized on (-) internal. Appropriate sweep timings will have to be selected depending on the duration of the individual single shots.

As indicated, the first eight single shots listed can be tested by writing a single record of a TM, rewinding, and then putting the control unit in read cycling operation. Since this operation involves moving a very small area of tape continuously across the head, excessive wear will be experienced on the tape if this operation is maintained for any length of time. It is therefore recommended that old tape be used or that the operation be held to a minimum length of time. The next five single shots are checked by having the control unit in a write cycling operation. The remaining single shots can be checked in like manner by following the modes of operation indicated in the methods column of the chart.

The "BOR Recognition" single shot can be controlled by the "Delayed Backspace Call Trigger" if the "Character Gate Trigger" is removed. It is not practical to tweak this single shot directly since it is a holdover single shot and therefore its timing is affected by the noise caused by the tweaking. The given tweak points will alternately turn the "Delayed Backspace Call Trigger" on and off.

Name	System Location	Type	Spec. Timing	Limits		Probe Point	Method
Read L.P.Del	70.06.01	SSE	20ms	16-24ms		S02M3	Rd Cycling-1st Record TM-Negative Output
Read Del	70.06.01	SSE	4ms	3.6-4.4ms		S02N5	Rd Cycling
Read Clock Rst	70.06.01	SSE	10us	8-12us		S03M8	Rd Cycling
Read Resp Del	70.06.02	SSF	4us			S05Q3	Rd Cycling
Rd Resp Timing	70.06.02	SSE	10us	8-12us		S05M3	Rd Cycling
Record Gate	70.06.02	SSD	150us	135-165us		S06L3	Rd Cycling
Disconnect Del	70.06.02	SSE	400us	360-440us		S06N3	Rd Cycling
Rd Cycling Del	70.13.02	SSE	15ms	12-18ms		S18E4	Rd Cycling - Negative Output
Write Del	70.05.01	SSE	10ms	9-11ms		S07G3	Wr Cycling
Rst Wr Tgr & Clock	70.05.02	SSE	10us	8-12us		S09C8	Wr Cycling
Wr Cycling	70.13.01	SSE	6ms	4.8-7.2ms		S19F6	Wr Cycling - Negative Output
Wr Cycling Del	70.13.01	SSF	9ms	6.9-9.6ms		S20A6	Wr Cycling
Rd/Wr Check Rst	70.10.03	SSE	10us	8-12us		S15E1	Wr Cycling or Rd Cycling
Fwd To Bkwd Del	70.11.02	SSE	25ms	20-30ms			Backspace
Bkwd To Fwd Del	70.11.02	SSF	28ms	22.4-33.6ms		S07W6	Backspace
Bkwd Stop Del	70.11.02	SSE	1ms	0.9-1.1ms		S08W7	Backspace
Bkwd Reset Del	70.11.02	SSE	3ms	2.7-3.3ms		S08W1	Backspace
Power On Reset	70.15.00	SS	20us	16-24us		S08M3	Reset Button
Wr Check Char Del	70.05.02	SSD	275us	248-302us		S12F2	Wr TM
Wr L.P. Delay	70.05.01	SSE	40ms	36-44ms		S07C7	Alternately depress Wr TM & Rewind-Neg.Output
Rd After Wr Del	70.11.01	SSE	6ms	5.4-6.6ms		S05U7	Depress in order-Start Wr,Stop Wr, Bksp.
Set Prep to Read	70.02.01	SSE	10us	8-12us		S04E1	Tweak S05A4
BOR Recognition	70.11.02	SSD	500us	450-550us		S08U3	Remove S04J-3,Alt. tweak S07S3 andS07S7

CARD TO TAPE - 759

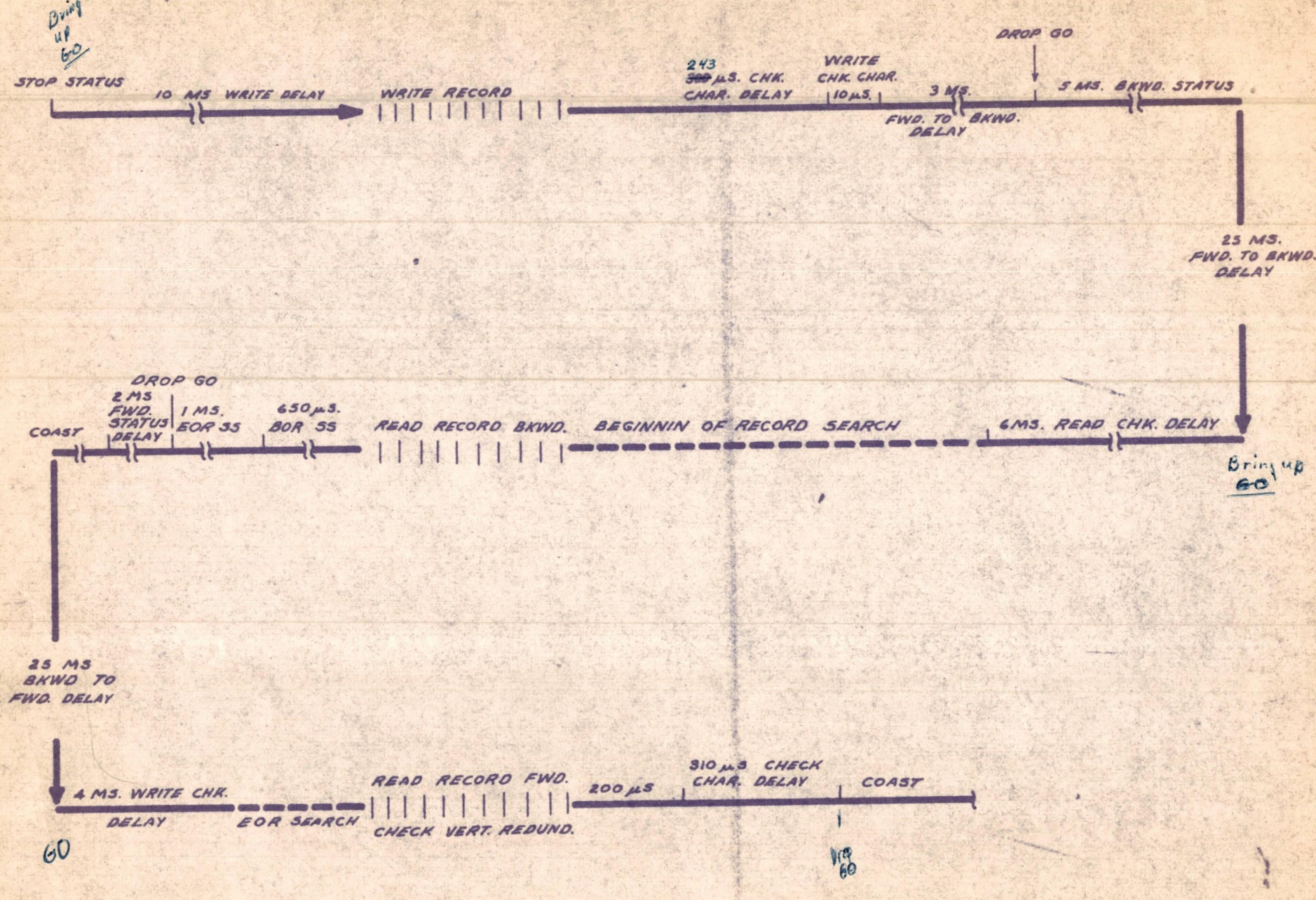
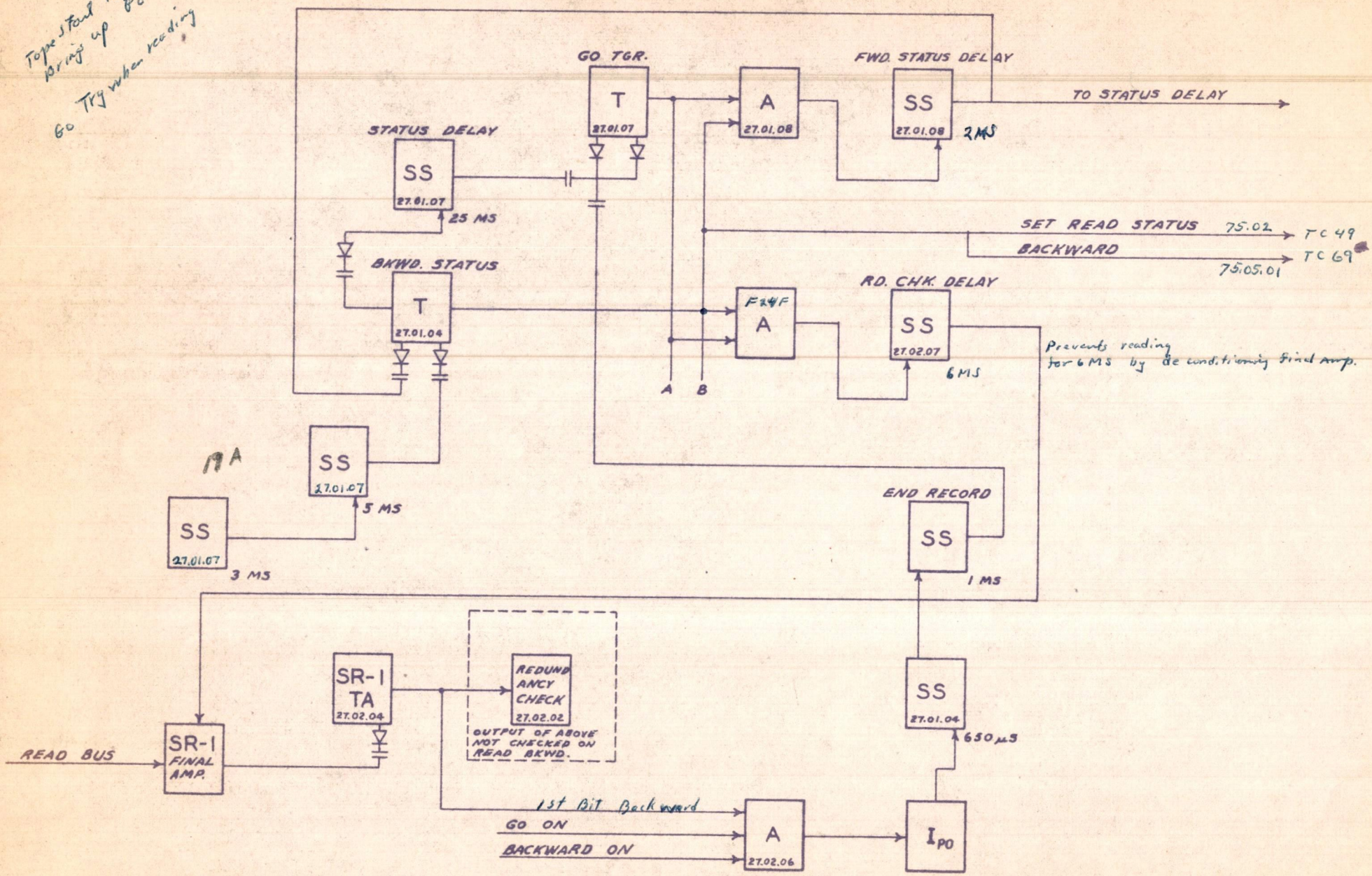


Fig. 15 18

Tape Start TRG initiates Trg
Brings up Go line
Go Trg when reading

714 CARD TO TAPE - READ BACKWARD



L.C.R. 9-6-55

Info Flow - Card Reader - write - backspace & read operation

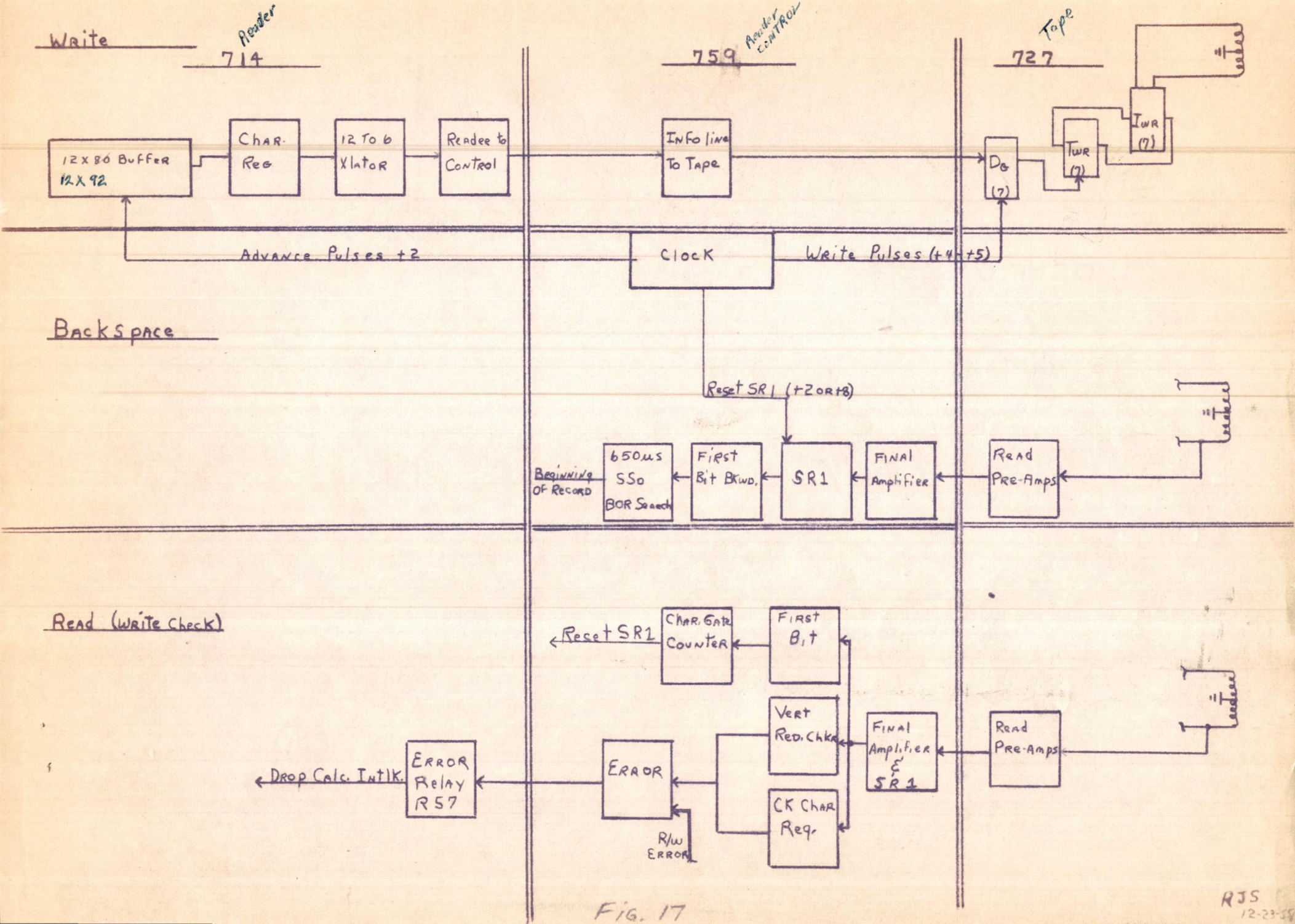
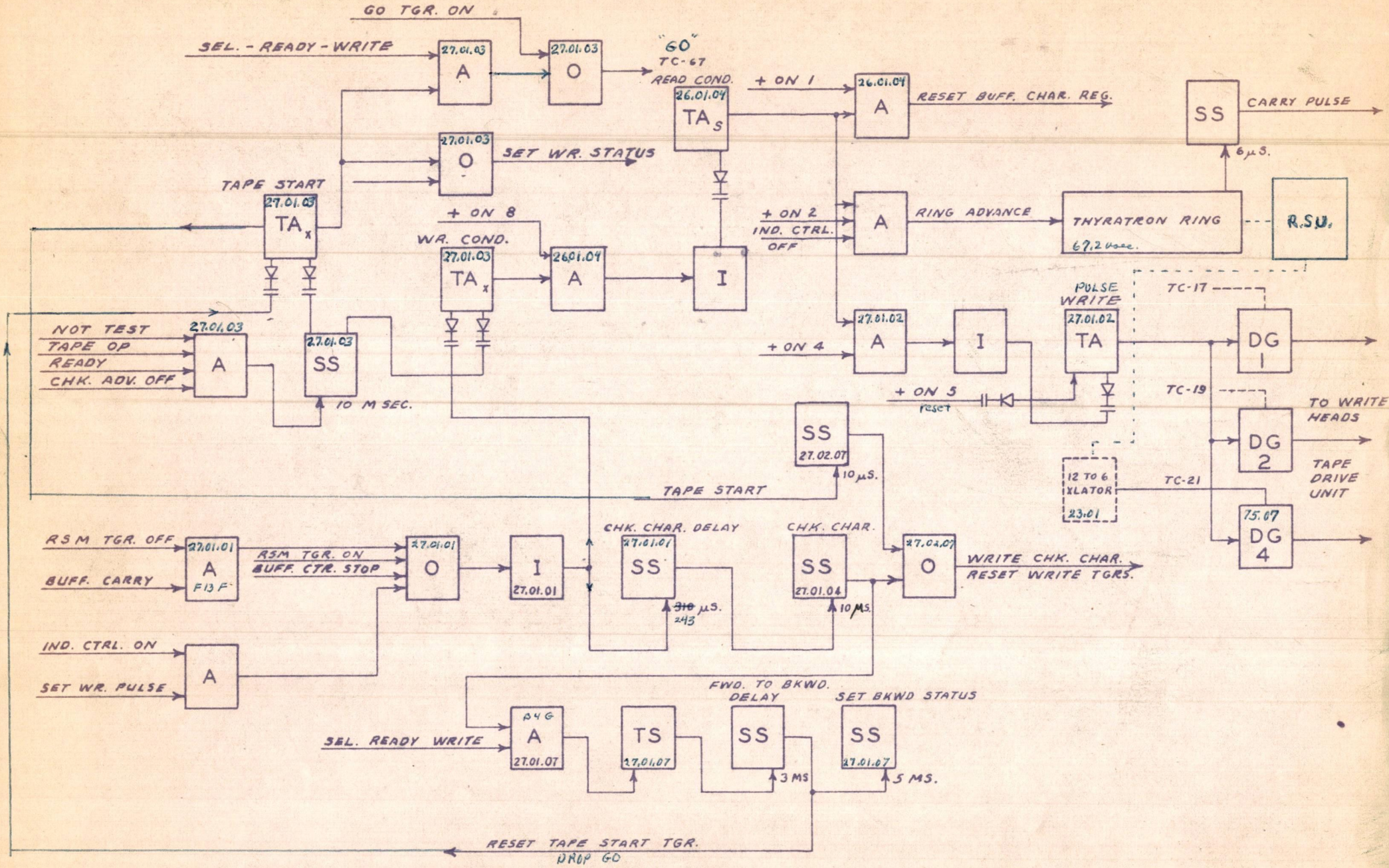


Fig. 17

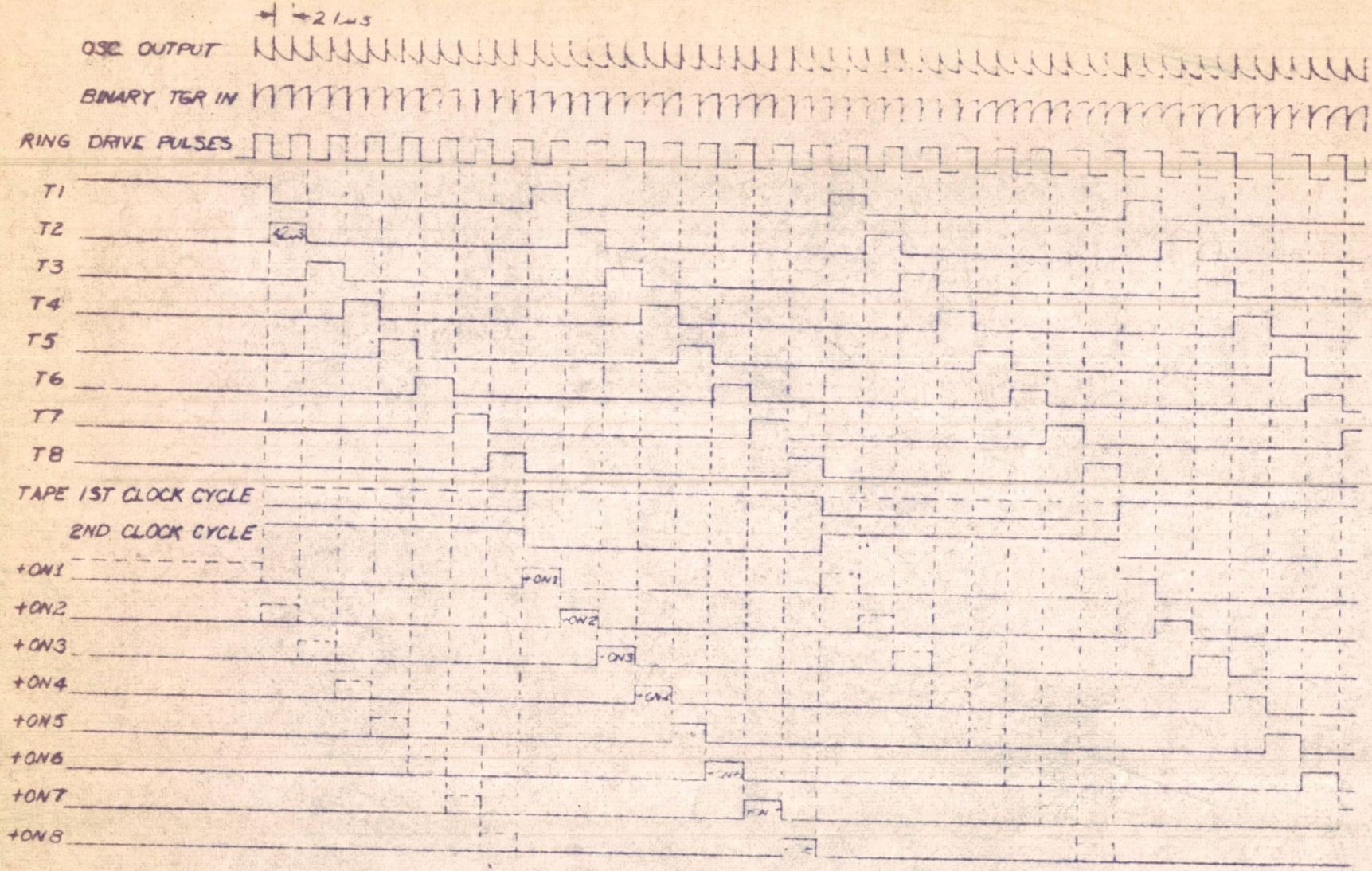
RJS
12-23-59

In

714 CARD TO TAPE — WRITE



C.C.K. 8-30-55



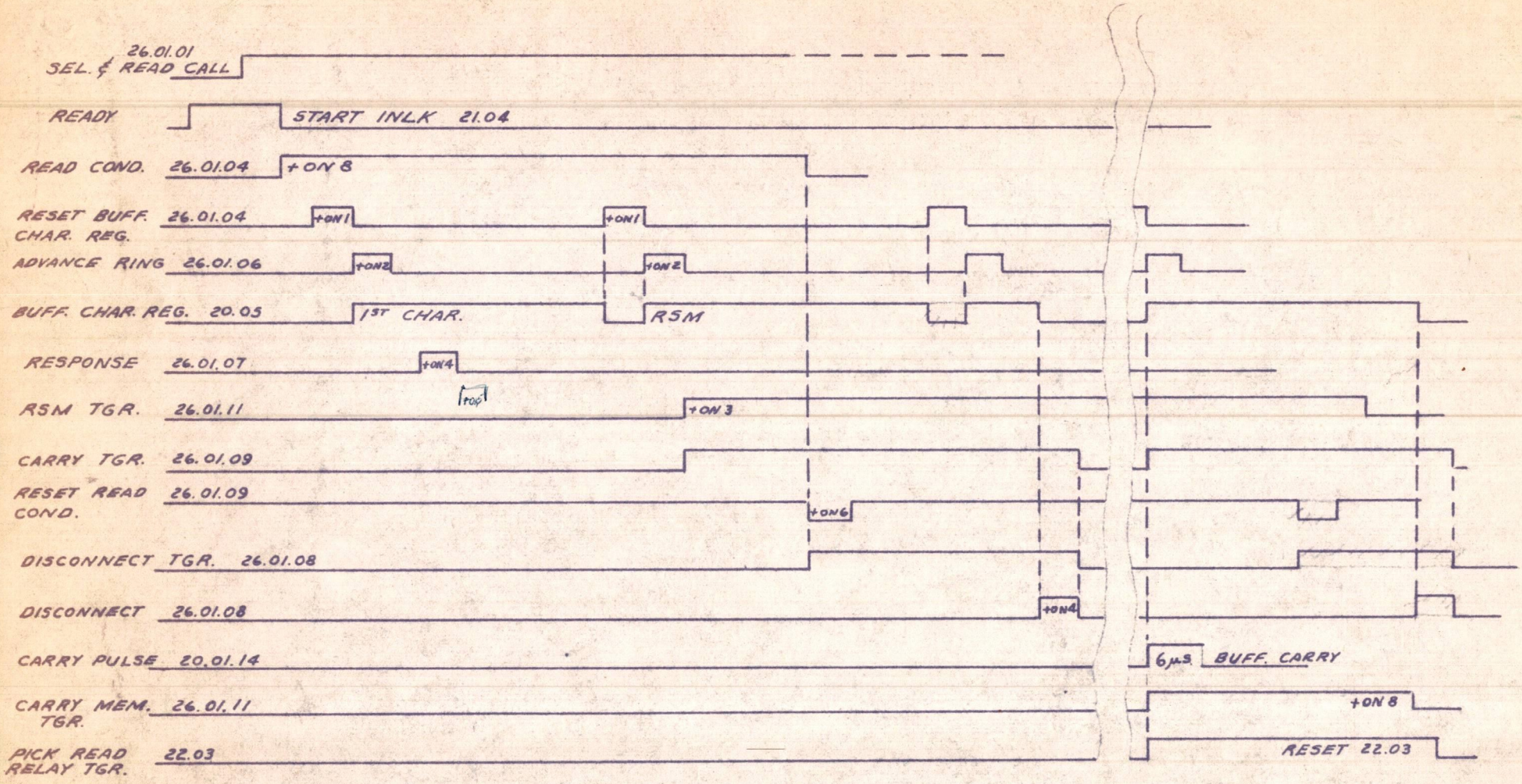
CLOCK & WAVEFORM GENERATOR TIMING

[redacted]

NOTE: DOTTED LINE TIMINGS INDICATE ALU OPERATION

CARD READER SYSTEM EDPM 702
705

FIG 5



CARD TO CPU
(ONE CHAR. AND RSM)
714 CARD READER

Fig 9 14

LOGIC FLOW 714 CARD READER

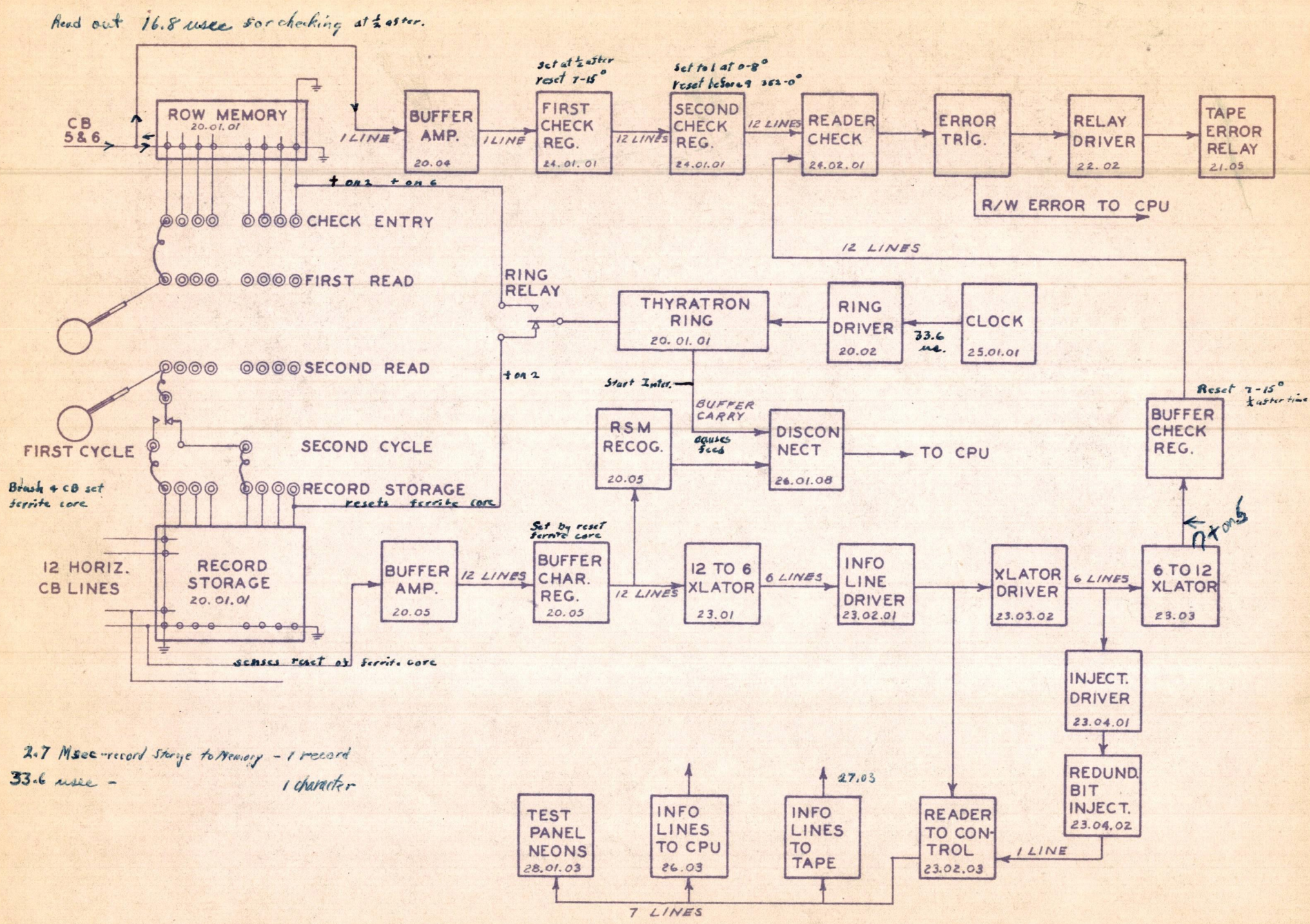
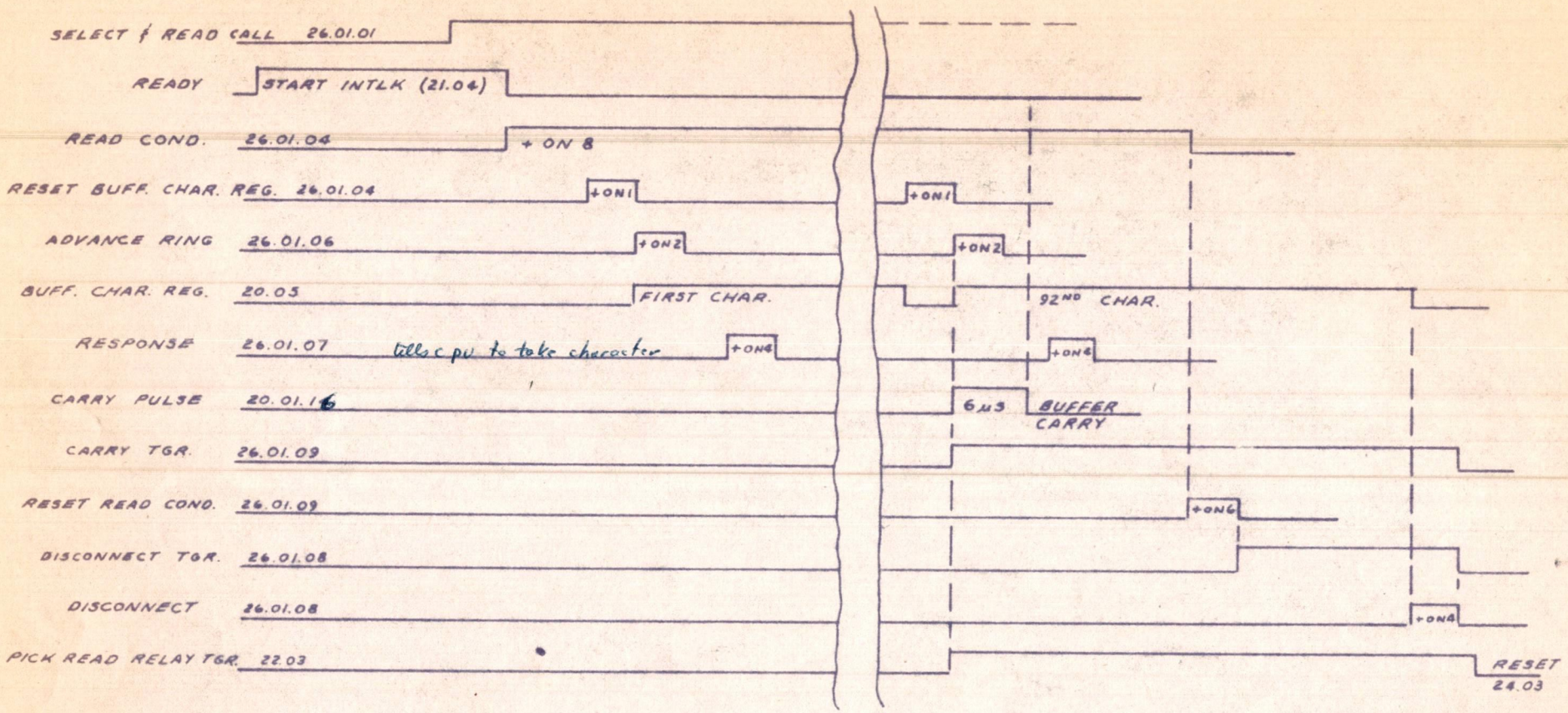


Fig. 13



CARD TO CPU
(92 CHARACTERS NO RSM)
CARD READER - 714

Fig. 10 15

92 positions
No more than 46 cols punch/card.

RUN-IN CYCLES -ALTERNATOR OP- 714 CARD READER

330 330 330 330

21.04 HOPPER CONTACT — PICK R-47
21.01 START KEY — PICK R-1
21.04 PICK R-12 — 340
21.02 HOLD R-12 — 85
21.01 PICK-HOLD R-2 — PICK R-11 — 85
START INTLK.
READ 245 CALL & SELECT R-40
21.05 PICK R-59 — 85
RING CARRY R-59
PICK FEED CLUTCH — CLUTCH
240 210 240 210 240

21.04 CB-36 PICK R-49 — 340 80
HOLD R-49 — 340 325
PICK R-23 — 215 215
PRIME RING 190 202 260 272 310 322
CLEAR ON RUN-IN 215 227 280 292
PICK R-10 — 325 337
HOLD R-10 FEED INTLK. — 325

21.06 CB-9 RESET CH. REG. 2 — 352 0
CB-8 CH. REG. 2 GATE — 0 8
CB-7 BUFF. CH. REG. & CH. REG. 1 RESET — 7 15
21.02 CB-26 PICK RING RELAYS — 2 227
& R-21,22
READ FIRST CARD
10 ROW MEM. 214
LCL MAKES BEFORE 218
Killed by 73 every other cycle
R-19,20,21,22 — 2ND CO. ROW MEM - 1ST CO. BUFFER
R-19,20,21,22 — 3RD CO. ROW MEM. 2ND CO. BUFFER
PICK R-29
21.03 PICK R-32 — 340 108
21.03 HOLD R-32 — 100 350
21.06.04 PICK & HOLD R-88 — 215 240
21.06.04 CB-13 PICK R-73 — 215 85
Suppress chk reg reset & pick Alt relays
21.06.04 CB-14 PICK-HOLD R-75 — 0 325
CB-29 PICK HOLD R-89 — 230 85

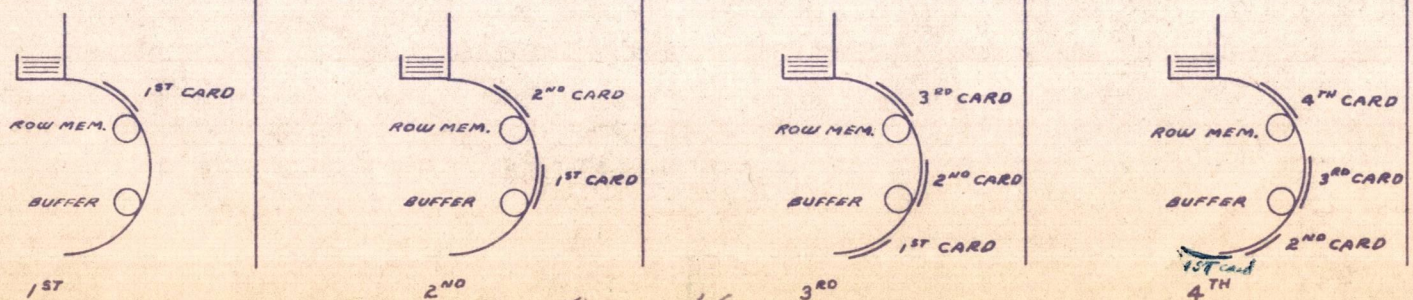


Fig #16

L.C.R 10-21-55

CARD TO TAPE — TYPE 759
WRITE - BACKSPACE - READ

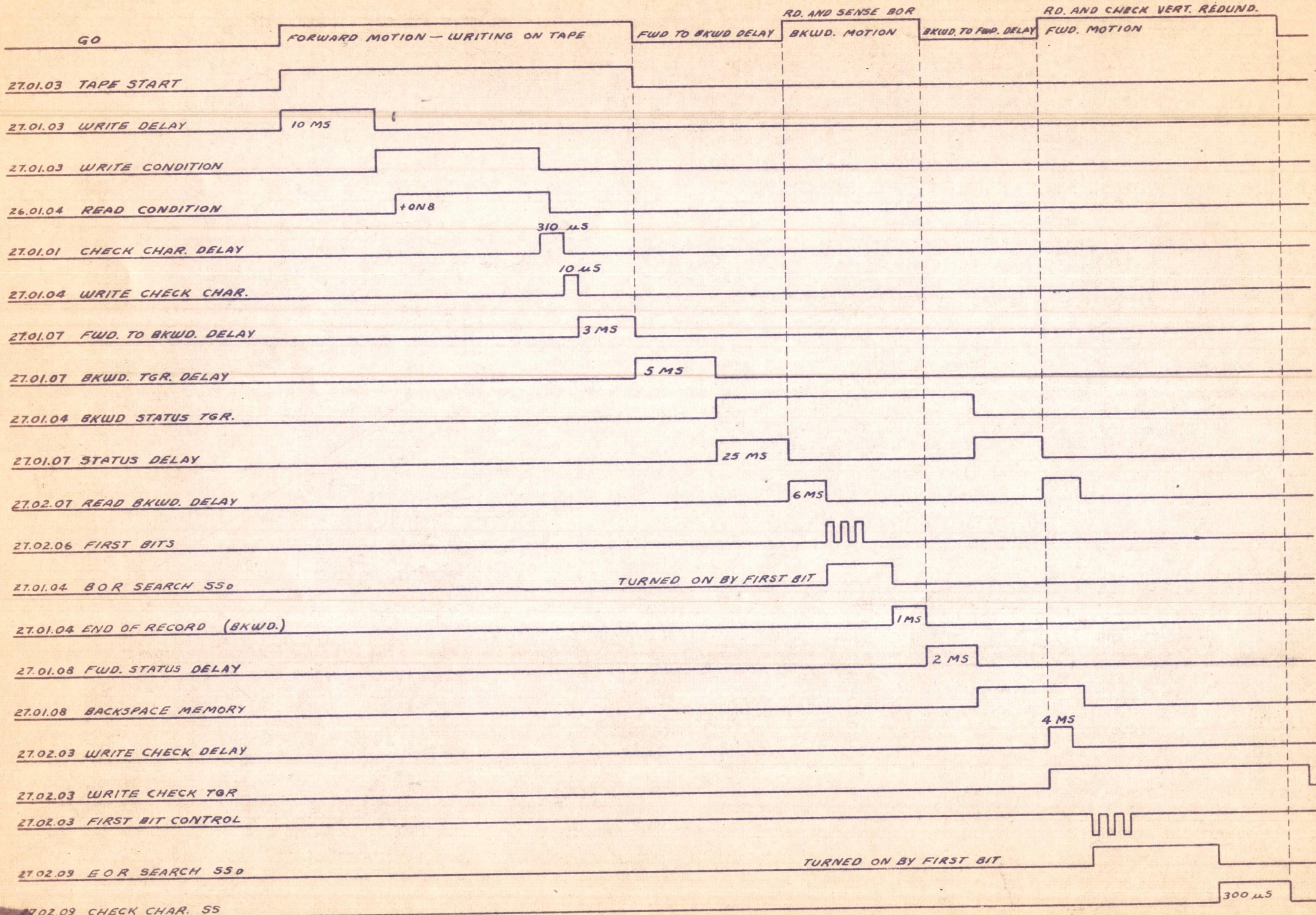


Figure 19

CARD TO TAPE - TYPE 714 - READ FORWARD

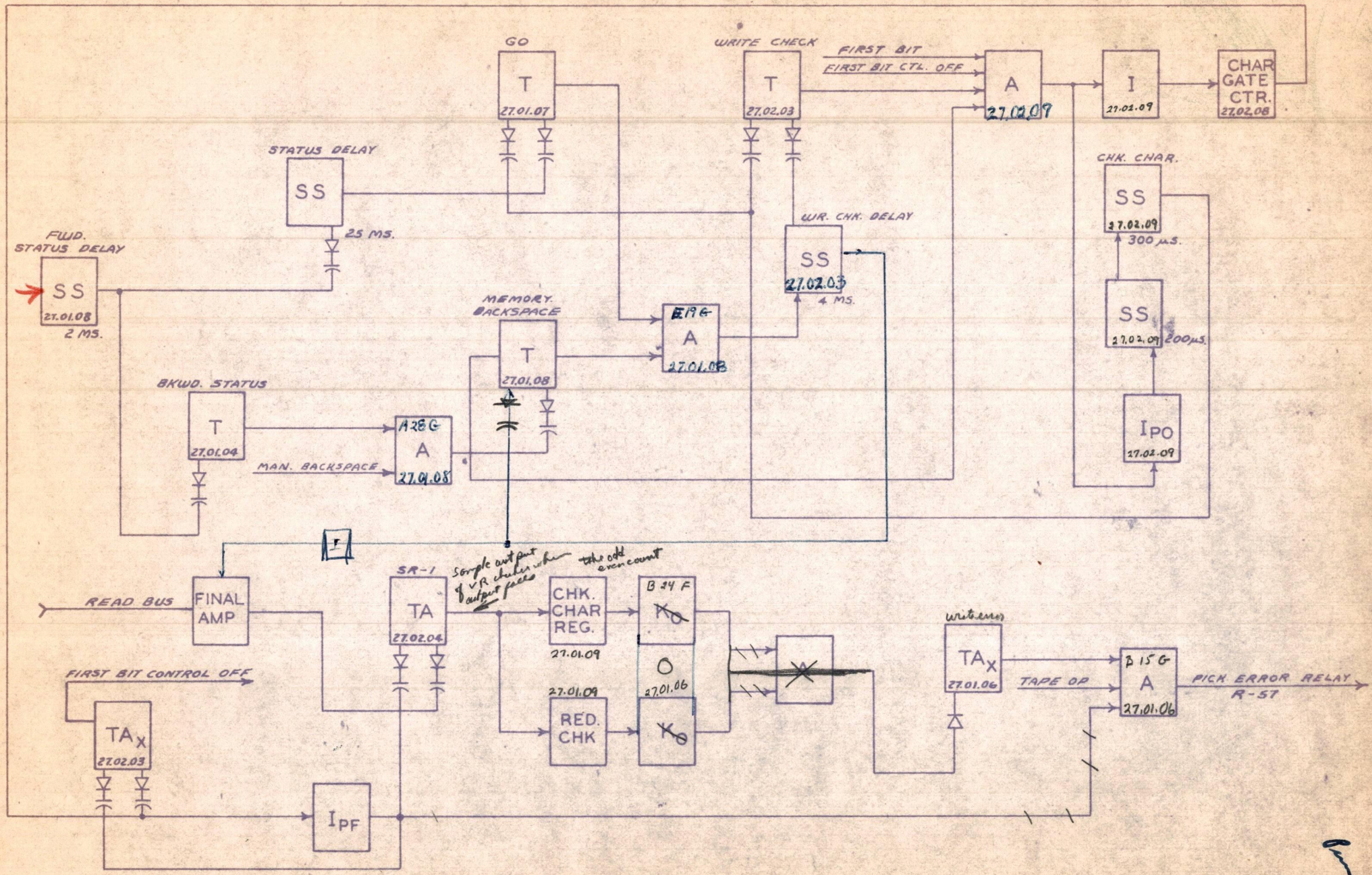


Fig 19-C

L.C.R. 10-3-55

CARD TO TAPE OPERATION - 714 CARD READER

WRITE TAPE MARK

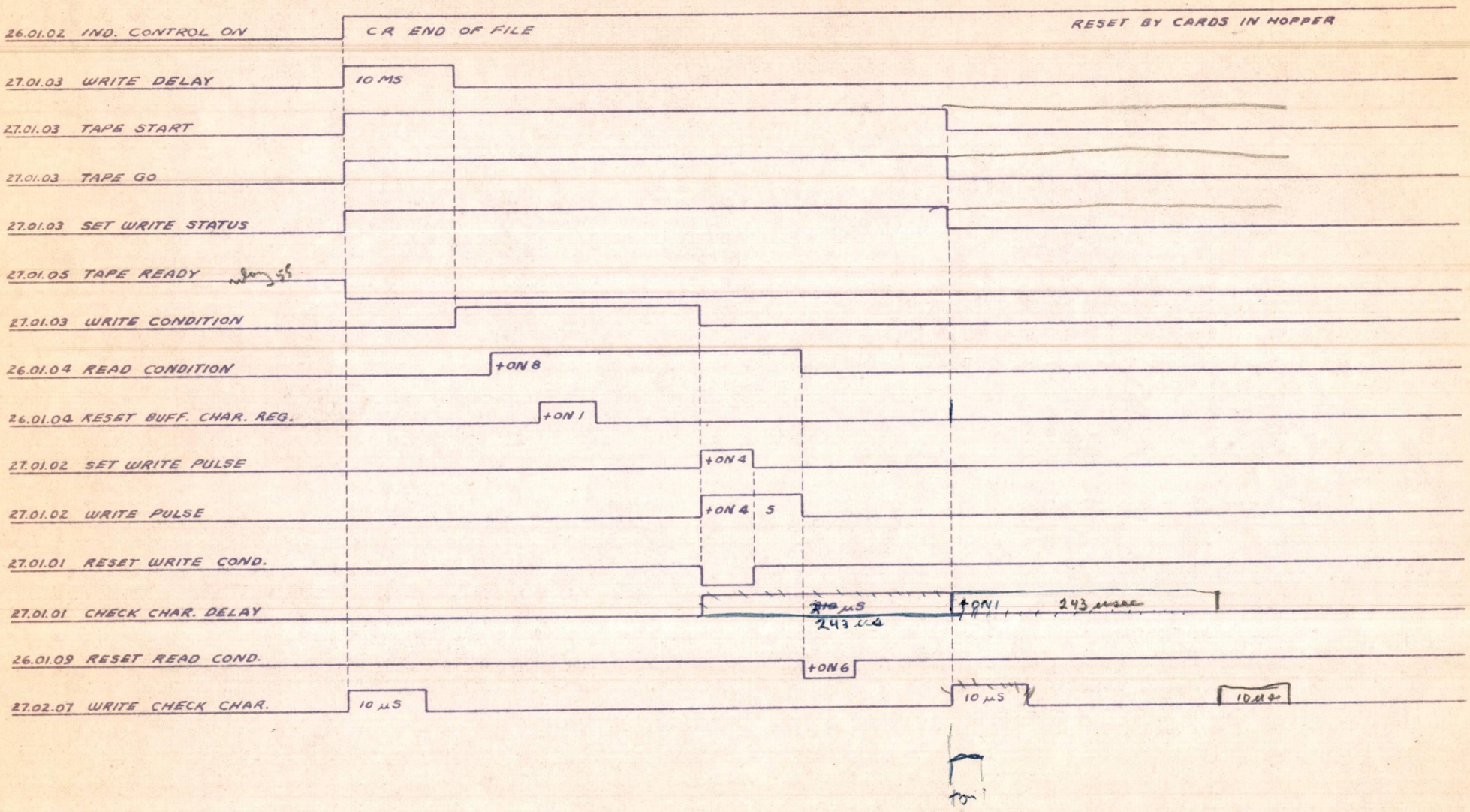


Fig. 19 20

CARD TO TAPE OPERATION - 714 CARD READER

MANUAL BACKSPACE

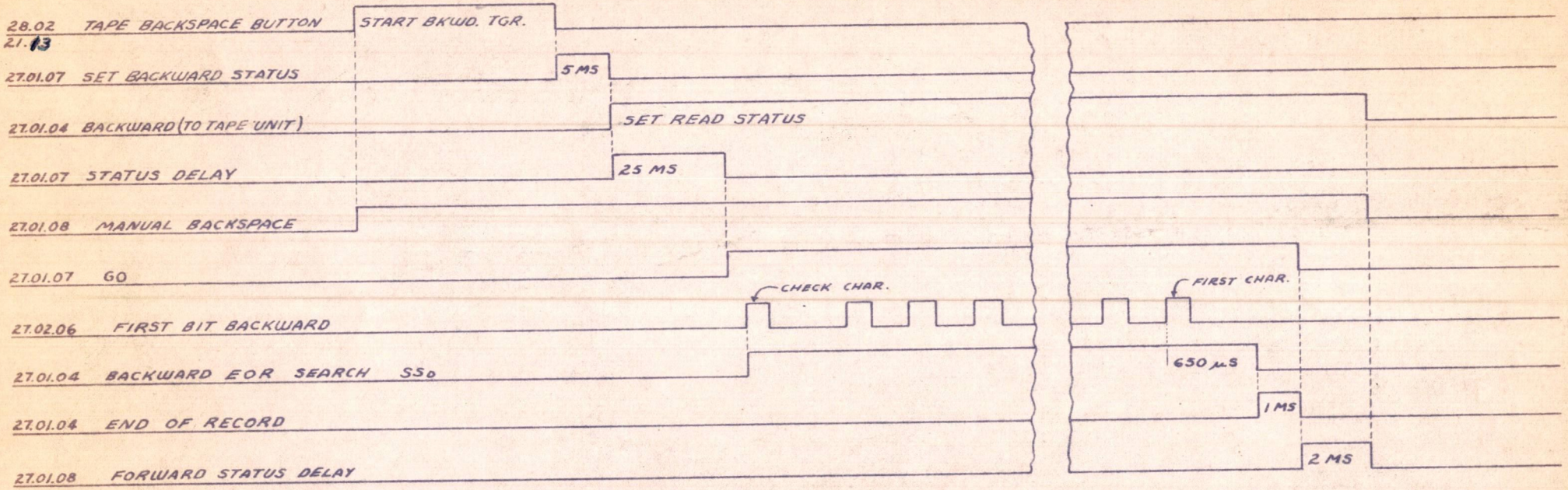


Fig. ~~20~~ 21

EDPM

CUSTOMER ENGINEERING TRAINING

LABORATORY PROCEDURES

TYPE 714 CARD READER
TYPE 759 CONTROL UNIT

Form No. 29-9231-0

CHECK PROCEDURES

The following information was taken from factory test procedures and may be useful to the CE in servicing the Type 714 Reader and 759 Control Unit.

A. On installation of the Reader and Control Unit, remove Fuse #9 in the card reader (clutch circuit fuse). This is to prevent any possible damage if the drive motor is incorrectly phased. After power is up, check direction of the card reader drive motor. Rotation should be CCW looking at pulley. Check blower operation in control unit and reader to exhaust to top of unit.

B. Adjust +48v supply to Card reader using a calibrated meter, for +48 volts. The potentiometer, on top of the 48 volt supply, located in the bottom of the card reader, is used to make this adjustment.

C. Check of Clock Operation - Ref. Pg. 25.01.04 and 25.01.05.

1. ALU timing - 33.6 usec.
   a. Check for clock pulse outputs of + on 1, + on 2, + on "2 (c) OR", + on 3, + on 4, + on 5, + on 6, + on 7, + on 8.
2. Tape Timing - 67.3 usecs.
   a. Jumper Q12r to Q20r. Refer 27.01.05 in Systems. Timing between clock pulses in step 1 should change to 67.3 usecs.

D. Check of Card Feed Mechanism.

Before starting, remove brush assemblies and check for burnt, bent or broken brushes. Also check resistance to ground--approximately 225Ω- read brushes: approximately 475Ω- check brushes. (Brushes out of feed). Resistance of horizontal core lines should be approximately 125Ω, measured from CB to Ground.
Check for 250 card per minute feed. Rate may be adjusted by screwing in pulley at end of drive motor.

E. Check of 12 to 6 Translator Circuit - Ref. Pg. 20.05.

1. Manually tweak on triggers (one at a time) for lines 1 through 12. Observe test panel neons at control unit for proper indications.

Example:

Line	Test Neons On
1	C-1
2	C-2
3	2-1
4	C-4
5	4-1
6	4-2
7	C-4-2-1

Example Cont'd:	Line	Test Neons On
	8	C-8
	9	8-1
	0	8-2
	11	C-B
	12	B-A

2. Tape Write lines may be checked in same manner as above. Ref. Pg. 27.03. Use scope to check lines.

3. 6 to 12 Translator in reader may be checked in same manner as above checking at point H2 of units R07A through R18A. Ref. Pg. 24.01.01. Use scope to check lines.

F. Check of Thyratron Ring Operation

1. Check for -55v bias at T3 and Y5 of units R01S through R16S. Set at -55v. Ref. Systems 20.01.16.

2. Place card reader in Continuous Run-In Condition.
   a. This may be accomplished by depressing Start Button and flicking hopper lever.
   b. Or this may be accomplished by Continuous Run-In Switch.

3. Check for advance ring pulses at R5a (Ref. Systems 20.02).
   a. Should be approximately 4.2 usecs wide, +10 to -30v amplitude.

4. Check advance ring current by placing scope input between points 02R7 and 02R8.
   a. Caution: Scope will be at +270 volts.
   b. Pulse amplitude should be at least 1.62 volts.

5. Sync Scope externally using thyratron pulse at R16S5.
   a. Pulse should be approximately 6 us wide and -150v in amplitude.

6. Check for pulses at all points by advancing from unit 16 down to unit 01S6.

7. Ring should operate correctly within a 35 volt range between -20 and -55 volts. Nominal value is -40 volts.

G. Check for clipping range of buffer amplifiers.

1. Using cards punched every other column, one row at a time, vary clipping pots between minimum and maximum to find voltages at which we pick up an extra pulse or drop a pulse. Record the voltages for each line. Each line should have at least a 2 volt range, somewhere between .5 volts and 4.5 volts. Range for row memory line should be between .4 and 3.0 volts. Nominal setting for buffer clipping is .7 volts above actual minumum and for R.M. clipping, 1 volt above actual minimum.

H. When using portable marginal check supply, the following limits should be reached while running 500 cards at each limit, using Control Panel B*. Voltage should be varied on both Reader and Control Unit.

-60	-78
	-54
-130	-137
	-117
+140	+133
	+150

Filament voltage on the control unit is 12.6 volts and on the reader 6.3 volts.

*Control Panel B is a control panel wired for 80 column operation. Wire, column for column, first Read #1 to Check Entry #1, etc. Second read #1 to Record storage entry #1, etc. Wire RSM to 81st position.

SINGLE SHOT TIMINGS

	Systems Page	Test Point	Time	Tolerance
____	20.01.16	R0125	6us	+20% - 10%
____	20.04	R18T2	6us	±20%
____	25.01.01	Q09J5	10us	±10%
____	26.01.10	Q17K1	50us	±20%
____	27.01.01	Q13X5	243us	±10%
____	27.01.03	INT	40us	±10%
____	27.01.03	INT	10us	±10%
____	27.01.04	INT	650us	±10%
____	27.01.04	Q12V1	1ms	±10%
____	27.01.04	Q12Y3	10us	±20%
____	27.01.07	Q06M4	3ms	±10%
____	27.01.07	Q08H4	5ms	±10%
____	27.01.07	Q06Q6	25ms	+20% - 10%
____	27.01.08	Q05Q7	2ms	±10%

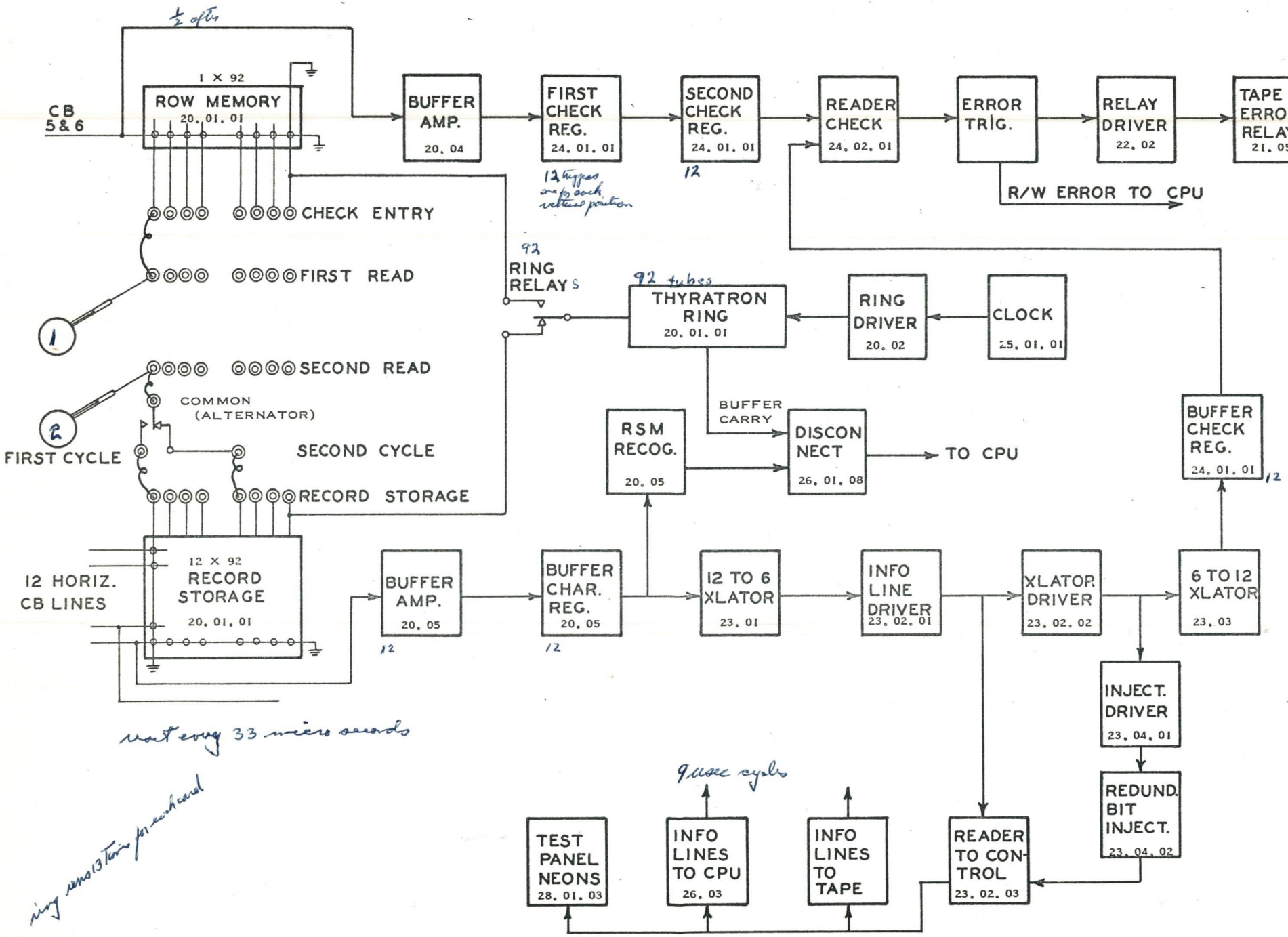
	Systems Page	Test Point	Time	Tolerance
____	27.02.03	Q09T2	4ms	±10%
____	27.02.07	Q07K2	10us	±10%
____	27.02.07	Q07N2	6ms	±10%
____	27.02.09	Q10W8	300us	±10%
____	27.02.09	INT	200us	±10%

INT = Internal.

reset every 16 micro seconds.

LOGIC FLOW 714 CARD READER

667 micro seconds per degree



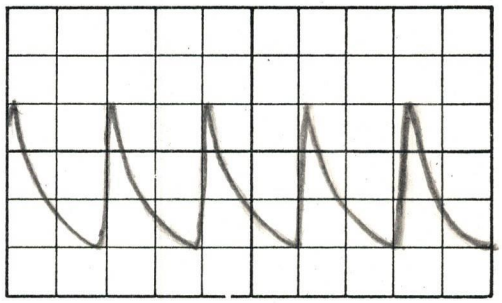
must every 33 micro seconds

ring scans 13 times per each card

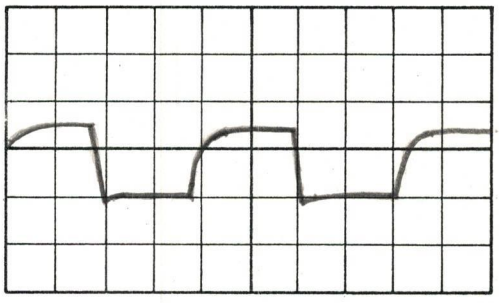
READER LAB WAVE FORM CHARTS

I. Clock

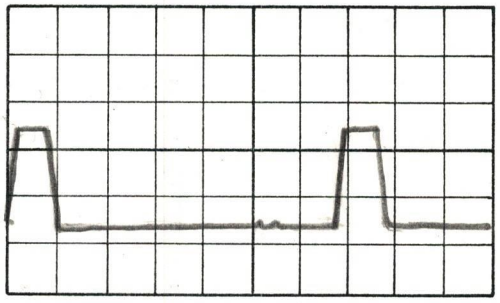
A. Oscillator
Scope Q09J-P5
Sync Int.
25.01.01



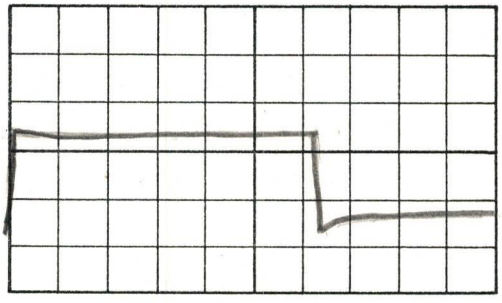
B. Clock Drive-Output
Binary Trigger
Scope Q10J-Q6
Sync Int.
25.01.01



C. Clock Pulses
Scope Q10J-K_2, K_6,
N_2, N_6,
Q11J-K_2, K_6,
N_2, N_6,
Sync Q10J-K_2
25.01.02 - 25.01.03 +ON 1

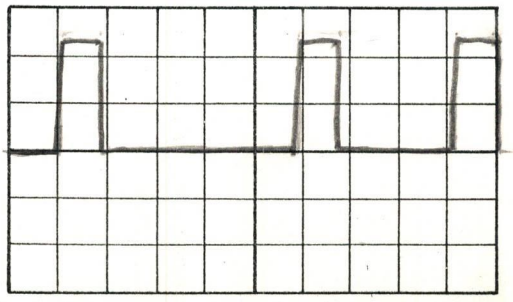


D. Tape Clock Pulse
Scope Q11J-Q2, Q6
Sync Q10J-K_2
25.01.03

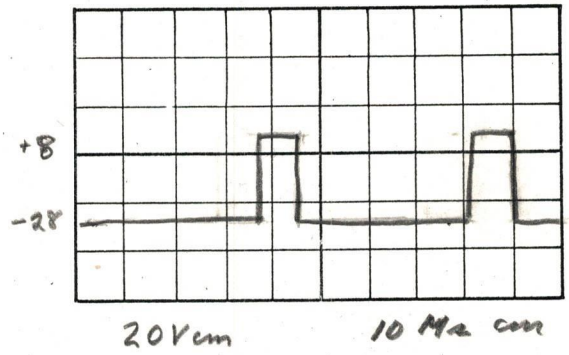


II. Run In-Lock In Continuous Run In +48

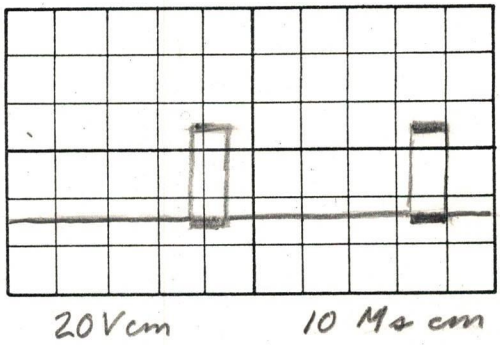
A. Prime Ring on Run In
Scope R18S-S5
20.01.17
Sync 1/2 after 1
21.06



B. Clear on Run In
Scope R03A-G7
Sync 1/2 after 1
22.01

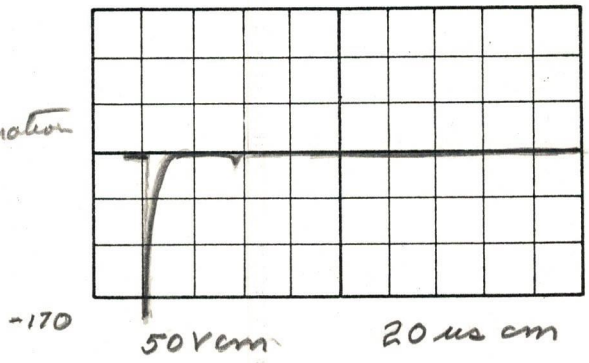


C. Advance Ring on Run In
Scope RSa
Sync 1/2 after 1
20.01

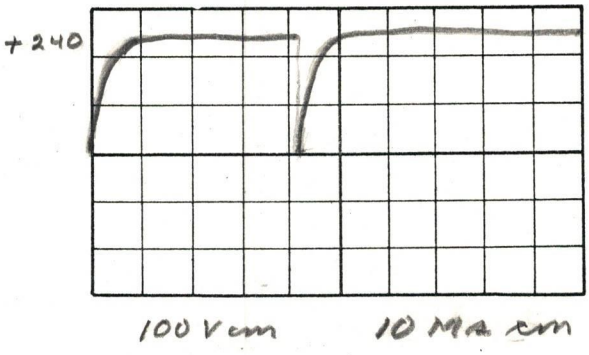


III. Ring Thyratron

A. TP
Scope R16S-S6
Sync R16S-S5
20.01.01

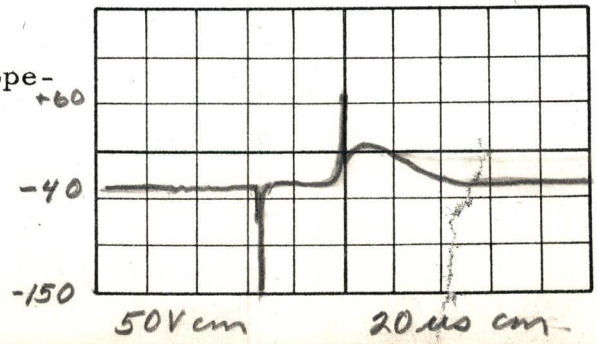


B. Plate
Scope Plate Side
of .01 uf Cond.
Sync R16S-S5
Check spike on both single
record and single character.

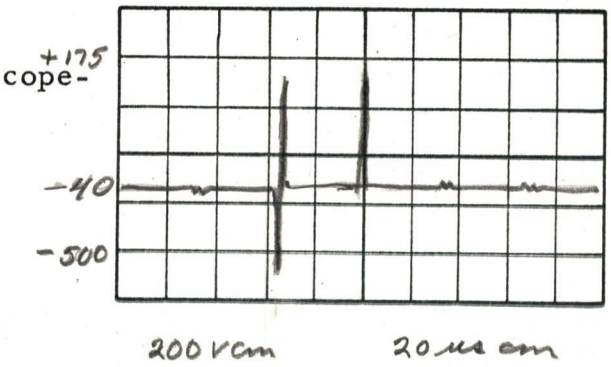


C. Grid

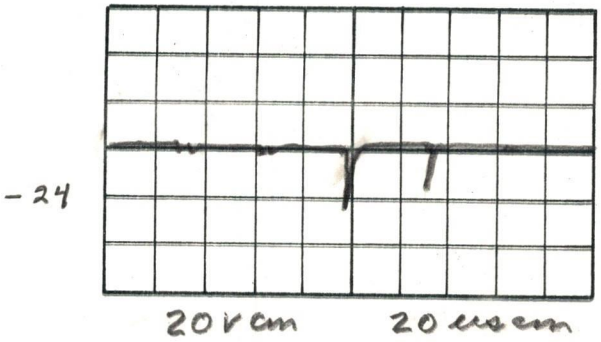
1. Grid and 20K resistor scope-
   Grid and 20K
   Sync R16S-S5



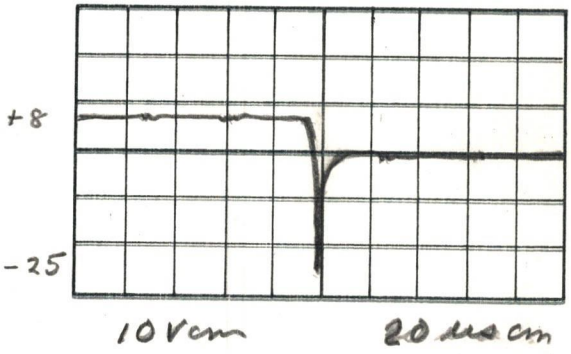
C. Grid
2. Core and 20K resistor scope-
Core and 20K
Sync R16S-S5



D. Cathode
Scope Cathode
Sync R16S-S5

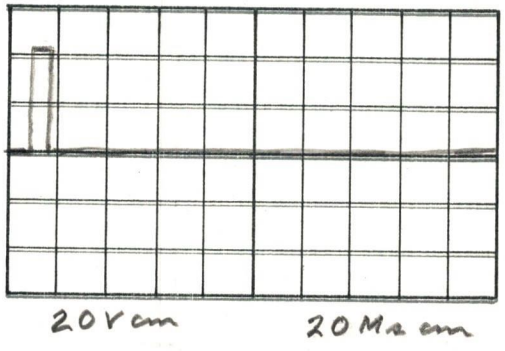


E. Thyratron Grid 2 400 μs
Scope - Grid 2
Sync - R16S-S5



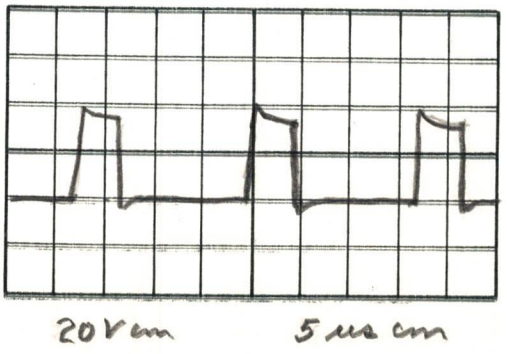
IV. Ring Pulse (Run in cards)

A. Check Advance Pulses
Scope 1/2 after 8
Sync 1/2 after 9
26.01.05 (Ground Q14A-E8 to bring up Select and Rd Call.)



26.01.06 20.02

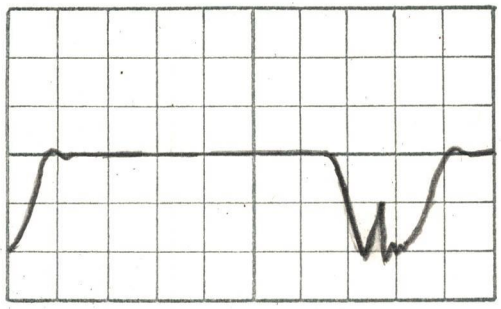
B. Ring Adv. (Before CD)
Scope - RSa
Sync 1/2 after 9
20.02



C. Ring Advance (Adv. Winding)
Scope - Float Across 2.7
R02J-R7
Ground-Fuse
20.02

6197 current drives 2 out until stop reaching by failing to pick ring carry relay

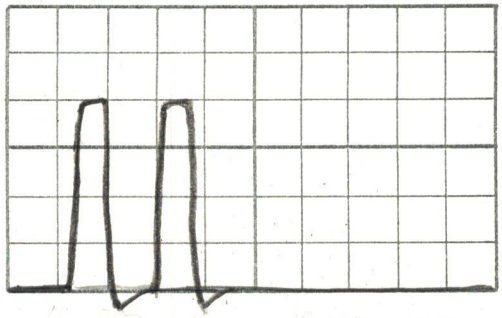
700 mils



D. Ring Carry
Scope R01S-Z5
Sync R01S-S5
20.01.16

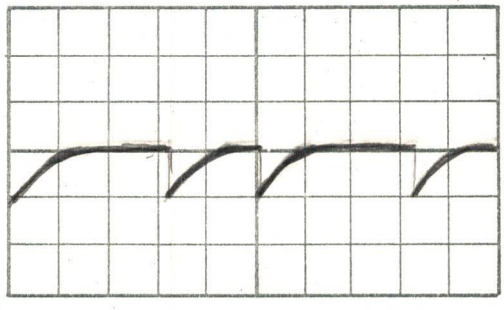
now measure

need storage



V. Buffer Amplifier (Use cards punched 55 bl 55 bl 55).

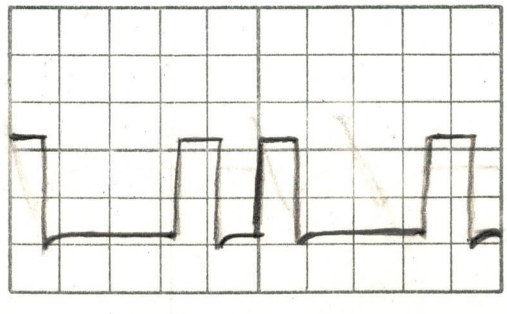
A. Grid Input
Scope Pin 1 Tube 8
Sync R14A-B2 (24.01.01)
20.04



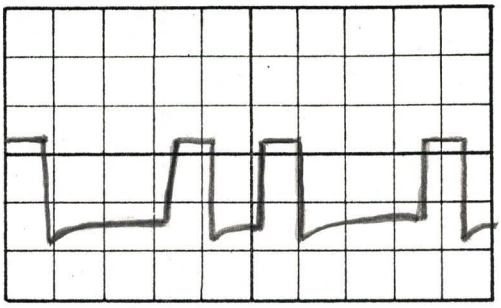
B. Plate
Scope Pin 5 Tube 8
Sync R14A-B2

C. After Ip
Scope Pin 7 Tube 7
Sync R14A-B2

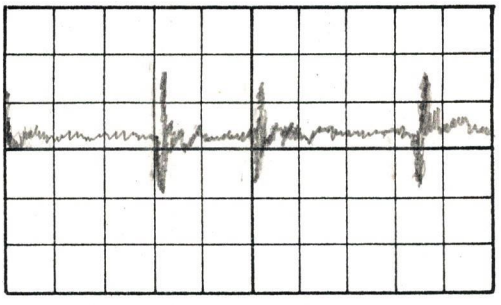
after 5S B



D. Check Info Line
Scope R18S-T2
Sync R14A3
(Use cards punched 55 bl 55 bl 55 etc.)



E. Secondary
Scope R18S-Z8
Sync R14A-B2



F. Primary
Scope R18S-Z4
Sync R14A-B2