HAROLD KORNBLAU

Issued to: Ron Dunbar

Branch Office: 170 Hagerstown

1400 HEATON ST

Department:

HAR OH

Address:

If this manual is misplaced, it should be returned to the above address.

IBM

Customer Engineering Reference Manual

1405 Disk Storage

Machine Record

MACHINE CODE	SERIAL #	SUFF	AC___ VOLTAGE DC___	CYCLES	PHASE	DATE INSTALLED
1405						

FACTORY INSTALLED SPECIAL FEATURES

FIELD INSTALLED SPECIAL FEATURES

CEM #	DESCRIPTION	MES #	B/M #	INSTALLED		REMOVED	
				MAN #	DATE	MAN #	DATE

This manual, Form 227-5541-2, supersedes but does not render obsolete previous Form 227-5541-1.

Copies of this and other IBM publications can be obtained through IBM Branch Offices. Comments concerning the contents of this publication may be addressed to: IBM, Product Publications Department, San Jose, California

Contents

Safety

Personal safety cannot be overemphasized. To ensure personal safety, make it an everyday practice to follow all safety precautions at all times. Become familiar with and use the safety practices outlined in IBM Form 124-0002, a pocket-size card issued to all CE's.

The following is a list of specific safety items to be borne in mind when working on the IBM 1405.

1. Remove disk storage power before starting removal and adjustment procedures. Do not operate access motor when access is disengaged from disk array.
2. The access mechanism is heavy. Handle with care during removal and replacement.
3. Disk and bearing removals and replacements should not be attempted without assistance. Some of the parts involved are heavy and awkward to handle.
4. Disk drive motor removal and replacement require two men as the motor is heavy and hard to handle.
5. Air pressure may be present in the air lines even though the air gage reads zero. Therefore, use care when disconnecting air line to avoid possible injury.
6. Two men are required to remove air compressor from its cabinet. The air compressor is heavy and awkward to lift.
7. Use the fuse pullers when changing fuses.
8. Remove power from the power supply before removing and replacing parts. This is best done by disconnecting power electric cables to the machine.
9. Wait at least five minutes after the power is off before attempting to work on filter capacitors. Discharge with a shorting wire to be certain that they are safe to handle.
10. Do not operate disk drive motor when disk array shields are removed.

1. Remove packaging and inspect each unit for physical damage. Inventory the installation parts against a check list.
2. Remove shipping wedges and braces on file, accesses, relay gates, etc.

   NOTE: If top array casting assembly is braced to main frame, the shipping group will contain casting mounting screw, P/N 58683, and casting mounting spacer, P/N 2109677. Remove brace and install screw and spacer as shown in 1405 Parts Catalog, page 8.

3. Level and align the 1405 to the other machines in the system.
4. Check the record start heads for proper clearance (.005" min.) to the sector magnet. See ADJUSTMENT under RECORD START HEAD in Section 3.
5. Install glass doors by tilting into upper channel and slipping into lower channel.
6. Place terminating plug, P/N 2131502, at C2 connector position on the starter box of the last 1405 installed in a given channel in the 1410. See Step 31.
7. Turn each access magnetic clutch by hand to check for binds.
8. Raise and lower the access carriage by hand, checking for binds. Rotate the disk array by hand, using the bottom disk only, and check for arm-to-disk clearance at middle and bottom of the array. See ADJUSTMENT under ACCESS MECHANISM AS AN ASSEMBLY, Section 3.
9. Install the remote compressor, using the following procedure:
   a. Remove packaging and inspect for physical damage.
   b. Remove shipping wedges and braces.
   c. The compressor assembly is spring-mounted at each corner to the main frame. Remove the nut and washers from the top of each spring mounting stud. A screw driver slot is provided on the top of each stud; use it to prevent the stud from turning while removing the nut.
   d. Align to other machines in system.
   e. Connect air hose to air receiver tank in 1405 and to fitting on oil filter at left end of compressor.
   f. Connect cables between 1405 and compressor, per cable drawings 2130759 (sequence interconnecting) and 2130760 (power interconnecting) provided in compressor shipping group.
   g. Mount kickstrips per reference drawing provided in compressor shipping group.

WARNING: Check crankcase oil level before operating compressor.

10. Omit this step if complete system is being installed. If the 1405 is being installed on an existing system, it will be necessary to make the following jumper connections to enable power to be brought up (System Diagram 38.11.21). Jumper the Power On switch operating point to the Emergency Off switch operating point. If C-31 and C-34 are utilized in the system, they must also be jumpered. Run 1401 function test.
11. Remove jumpers installed in Step 10. Install signal and interlock cable, from the 1401 to the 1405. Biscuit connectors on cable are labeled to correspond to connector positions on gate O1A1. Install ground wire in cable under the screw to the Tape Unit Connector in the 1401. Check wall outlet for 208-volt, three-phase, 60 cps power. Connect wall plug and turn on wall switch. If 230 volts are supplied, refer to logics 75.58.11.1 and 75.58.21.1 for three transformer tap changes.
12. On a multiple file system, power lines L1, L2, L3 to the power distribution box must be the same for each line on all files on the same channel.
13. Turn off all Access Motor switches.
14. Turn Power Sequence Mode switch to "Manual" position. Depress File Start, then File Stop. Note direction of disk rotation. Counterclockwise rotation, as viewed from above the disk stack, is correct. If rotation is incorrect, disconnect wall connector and reverse two wires at line side of circuit breaker in Power Distribution Box. Check rotation again.
15. Check air compressor and compressor blowers for counterclockwise rotation when viewed from relay side (front) of machine. Rotation may be changed by reversing the two leads to the motor.
16. Check air pressure at the file per procedure outlined under COMPRESSOR TESTS in Section 3 of this manual.
17. With Access Motor switches off and Access Inop switch on, turn Power Sequence Mode switch to Local Automatic (LA) and depress Local Automatic Start switch. Compressor should come on in 40 seconds. Blower fans and DC should come on in 55 seconds.
18. Check all muffin fans on the 1405 for correct air flow through the gate, bottom to top. There are three fans in the file electronics gate, three in the file control unit, two in the power supply and one in the heater box.
19. Using a Simpson meter, check the output voltage of the −6, +6, +6M, −12M, −12, +30, and −36 volt supplies at 01B1 Row J to card location 18 (00.75.55.0). Adjust any that are not within tolerance.
20. Turn the Access Inop switch off. Check to see that heads are not down. Check clutches manually for clutch lockup or drag caused by both clutches driving at the same time. If drag is noted, adjust Clutch Amplifiers according to the procedures outlined under SERVO CLUTCH AMPLIFIER AND MOTION CONTROLS ADJUSTMENT in Section 3. Turn on Access Motor switches and note any apparent drag by turning off the access motor to see if the motor coasts to a stop. Repeat for all accesses.
21. Pull the Emergency Off switch on the 1405 to see that power drops on the entire system. Perform the same check by activating the Emergency Off switch on the compressor.

22. Turn off DC power in the 1405 and run the 1401 or 1410 diagnostic test. Correct any troubles found that are due to circuits in the 1405.
23. Turn on 1405 DC power. Run the 1401 or 1410 diagnostic test and again correct any trouble owing to 1405 DC power being on.
24. With Access Motor switches turned on, depress start reset on the 1401 or 1410. This should cause all accesses to seek 00000 with no address relays energized. Transfer Track and Disk No-Null switches and note action. Track No-Null should cause the track detent to disengage, but the arm should remain motionless. Disk No-Null should cause the arm to access to the home position, the disk detent to disengage, but the carriage to remain stationary. Returning the switches to neutral should cause the arm to access back to 00000. Repeat for each access.
25. Check oscillator frequency in the following manner. Program the machine to loop full-track write and full-track write-check operations in the move mode. Scope count one trigger at O1A2G22N while synced on *end record gate* and *record 5*. Scope should be set for 100 μsec/division. The elapsed time from *end record gate* to the first count one pulse must be 720 ±100 μsecs for single file systems. For multiple file systems the elapsed time for one file must be 720 ±100 μsecs and for the remaining files it must be 720 (+150 −100) μsecs. In a 1410 system with multiple channels, the conditions above apply to the machines in each channel.

    If the elapsed time does not fall within the range stated, perform the File Clock Oscillator adjustment in Section 3. For future reference, record the oscillator frequency.
26. Check the read amplifier by programming the system to perform a continuous read operation to read the information recorded at the factory. Check the output at the second linear amplifier. See READ AMPLIFIER ADJUSTMENT in Section 3. Check both inside and outside tracks. For future reference, record the output from 1K04.
27. Addresses should have been written on the 1405 at the plant. Transfer the Address Write switch and program a write address operation on the Customer Engineering track. (A "T" is used in place of a 0 for the compatibility character of the address on the CE track). Verify the operation either by scoping the write data or by incorrectly writing an address and then rewriting the address correctly.

    Do not leave a CE track incorrectly written. This will avoid unnecessary trouble if this track is used to test a read or write operation at a later date.
28. Customer addresses are written on the 1405 at the plant. It is important that these addresses be verified before the customer's data is loaded. The following program can be used to cause all records to be read, to stop on an address compare error, and to cause the disk address in error to print out.

```
497 498 499 500     502             505 506     508 709
 7   1   .   0   0   0   0   0   0   0   0   ‡   ‡

400        407      412         420      425      430
M%F0500    B499Y    M%F1500R    B499N    B468X    A497506

437         445     449         456          464
B4995060    B412    A498505     B4995025     B400
```

If the system does not have advanced programming, enter the following:

```
468        475        480        486 487    490
L501202    L505207    L506208    2   B430   _
```

If the system has advanced programming, enter the following:

```
468        475 476    480
P500201    2   B430   _
```

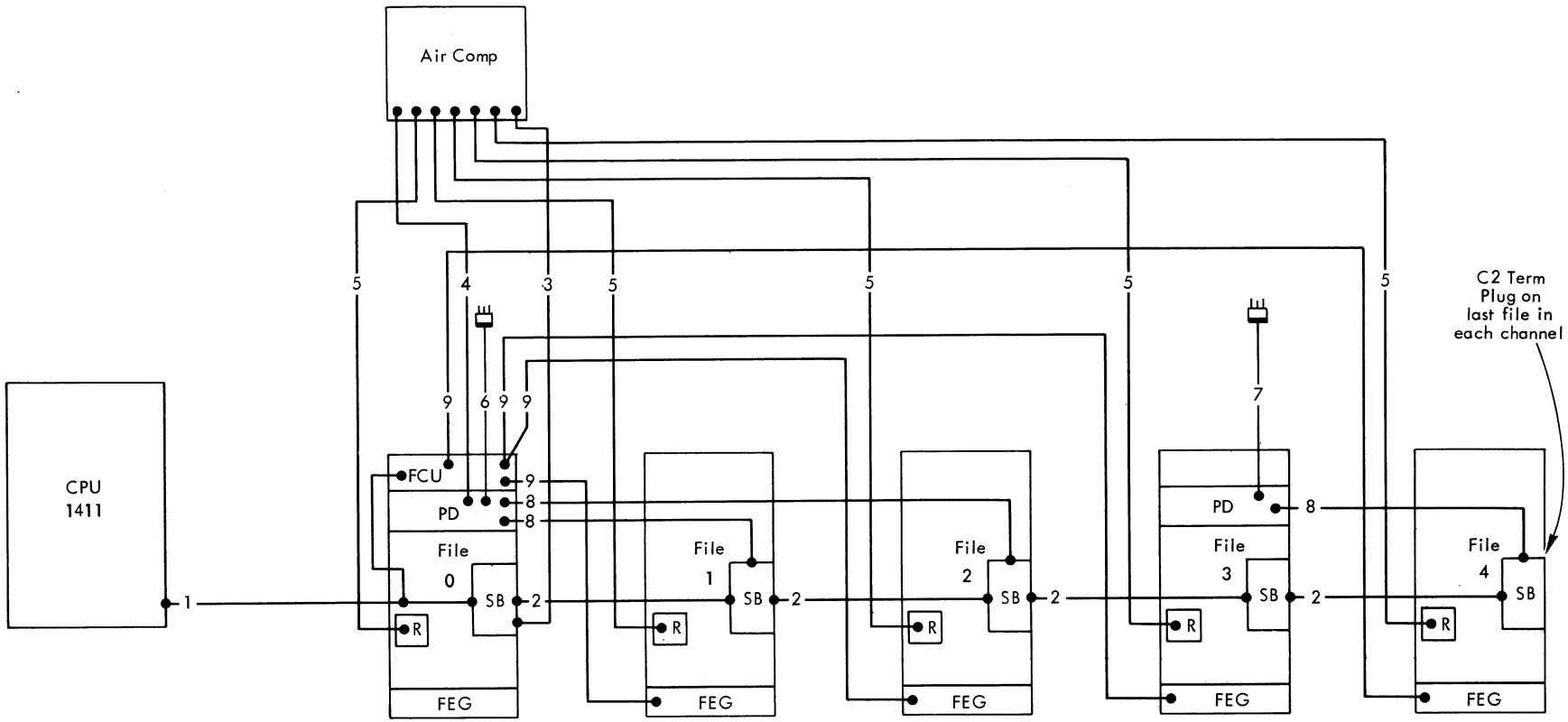
29. Install kickstrip brackets and kickstrips.
30. Run the 1401 or 1410 diagnostic tests for the 1405.
31. If multiple files are installed, file 0 should be checked out first, using terminating plug on C2 of file 0 in each channel, with the other files not connected. Connect the remaining files as required by the system using logic 75.20.70.1. Figure 1 is provided as an example.

    NOTE: To servo to CE tracks, if attachment unit is plugged for the additional files, the following cards must be pulled when testing first file.

    01A1E26 – Mod 1
    01A1F26 – Mod 2
    01A1G26 – Mod 3
    01A1H26 – Mod 4

    To determine which file is to have the compressor, check the file starter boxes for the absence of a jumper between SBTS1-19 and SBTS1-20 (logic 75.58.11.1). The absence of the jumper will indicate the file that should have the compressor.

    Run the pertinent checks given for a single file installation.
32. Perform Read/Write head PM after installation and after the first 40, 80, and 120 hours of power on time. An excessive amount of oxide build up should not exist. A build up of deposits during the first 120 hours is abnormal.



CABLES

No.	P/N	Description
1	761366	Signal & Interlock Cable CPU to 1st File Channel 1
	761369	Signal & Interlock Cable to 1st File Channel 2
2	2130771	File to File Seq & Interlock C2 to C1 of Succeeding Files
3	2130759	Compressor Sequence
4	2130760	Compressor Power
5	21302365	Compressor Air
6	2133519	Power to File 0
7	2133519	Power to File 3
8	2130789	File to File Power
9	2130785	File to File Signal (Logic ref. 75.20.70.1)

PD	Power Dist Box
FCU	File Control Unit Panels 01A1 & 01A2
FEG	File Electronics Gate 01B1
R	Air Receiver Tank
SB	Starter Box

Diagram shows 1st file of channel supplying power to air compressor, other channel will not have compressor power & sequencing connections.

Figure 1. Multiple File Cable Layout

Section 1 Scheduled Maintenance

Contents

Approach to Scheduled Maintenance

The prime objective of any maintenance activity is to provide maximum machine availability to the customer. Every scheduled maintenance operation should assist in realizing this objective. Unless a scheduled maintenance operation cuts machine downtime, it is unnecessary.

Do not adjust or disassemble a unit that is working properly, even if tolerances vary from specifications.

Visual Inspection

Visual inspection is the first step in every scheduled maintenance operation. Always look for corrosion, dirt, wear, cracks, binds, burnt contacts, and loose connections and hardware. Alertness in noticing these items may save machine downtime later.

Table 1.1 Scheduled Maintenance Routine for Single Shift Usage (adjust frequency for multiple shift accordingly)

CODE	UNIT OR ROUTINE	FREQUENCY	LUBRICATE – CLEAN	OBSERVE
1	Access Mechanism	6	Tilt access out as described on page 14 and clean Read/Write Heads. Replace worn tubing. Add drop of #6 oil to clutch shaft bearings.	Check for loose or malformed head-retaining springs. Check pinion for freedom of vertical movement on shaft. Check for freedom of lateral movement of clutch on shaft, with pinion disengaged. Check clutch brushes and commutator.
0	Blowers and Filters			Check all muffin fans for rotation. Replace filters as necessary.
9	Compressor and Air System		Check oil level and fill with IBM 451012.	Check air pressure for 70 to 90 psig. Drain moisture from drain pan. Drain moisture from receiver tank (in file) and check filter element.
1	Access Mechanism	13	Lubricate access mechanism sparingly with IBM #6 on V surface of way, access arm sliding surfaces, carriage felt wipers, disk and track detents.	Check for free movement of carriage and access arm. Note any wear in disk detent linkage. Inspect disk and track detent switches for burned or loose contacts. Check track detent switch adjustments. Check access cable tension.
8	Electronic Servo			After above checks, check DC voltages, disk and track null systems, and clutch balance. Adjust dampening for smooth servo and proper access time.
9	Compressor and Air System			Check air pressure at file for 55 +1, −2 psig.
1	Access Mechanism	26	Lubricate pinion shaft with IBM #357830.	
9	Compressor and Air System		Every 500 hours, drain and refill crankcase with IBM #2127714.	Check filter elements in air inlet discharge bowl.
6	Disk Array	26	Clean Disk Surfaces with disk cleaning paddle as necessary.	Run-down time. If excessive shaft-motor should be replaced (See page 29)
9	Line Cord			Check for safe condition and proper grounding.

Scheduled Maintenance Procedures

Specific items of scheduled maintenance are scheduled on punched cards processed in the local customer engineering office. Details of scheduled maintenance operations are listed in the Scheduled Maintenance Routine Chart (Table 1-1). During normal scheduled maintenance, perform only those operations listed for that scheduled maintenance period. Details on adjustments, service checks, and removal and replacement are given in Section 3. Observe all safety practices.

Mechanical Units

The three basic scheduled maintenance steps performed on every mechanical or electromechanical machine are cleaning, lubrication, and inspection. Do no more than recommended scheduled maintenance on equipment that is operating satisfactorily.

Electronic Circuits

Diagnostic programs, marginal checking, and pulse checking are the three basic tools in scheduled maintenance of electronic circuits. All are effective in locating potential and intermittent troubles. They are also excellent troubleshooting tools. When using them for scheduled maintenance, use them only as directed on the scheduled maintenance chart.

Do not adjust pulses unless the condition of the machine requires it.

Section 2 Diagnosis and Service Aids

Contents

File Techniques

WARNING: When working on the file, extreme care must be taken to avoid altering or damaging the customer's records.

File troubles generally stem from three sources: (1) servo troubles, (2) wrong reading, and (3) wrong writing.

Servo Troubles (Figure 2-1)

Erratic Servo Operation. Erratic servo operation can be caused by poor magnetic clutch brush contact. Check for proper tension and proper riding on the slip rings.

A quick check on the disk and track damping can be made by observing the action with servos of 20 disks and servos of 40 tracks. These servos tend to be the most critical but still should be smooth. Before disk and track damping adjustments are made, the electrical clutches must be balanced and any mechanical binds must be removed.

Clutch current can be calculated by using the following formula:

$$\text{Clutch Current} = \frac{\text{Voltage at Pin H (Clutch Driver Card)}}{7.2}$$

The access motor spindle is designed to slide up and down the keyed motor shaft and is held against the clutches by spring tension. Check this spindle for free up and down sliding motion and keep the mechanism carefully lubricated.

If the access time builds up, be sure to check all mechanical as well as electrical elements. Access time is a good indicator of general mechanical condition as well as electrical condition.

A quick method of checking track potentiometer linearity and of adjusting the track null follows: Connect a scope direct probe to the track error signal hub. Set the vertical amplitude to .1 volt/division, DC horizontal sweep to 500 μsec/division, and trigger for continuous sweep. Zero the scope with no signal applied. Start the DT file access test. The error signal for each track will appear on the scope. Observe extreme plus and minus readings to determine linearity. If the readings are greater than .76 volt apart, the track potentiometer should be replaced. If the readings are less than .76 volt, a mid-point adjustment should be made. This can be done by stopping the program, turning off the access motor, adjusting the proper position, then rerunning the access test.

Servo Oscillations. Double detenting (chatter) of the access arm can be caused by a loose fit between the magnetic clutch rotor and the clutch shaft. With the access drive motor turned off and the clutches energized and prevented from rotating, grasp the capstan and note if there is any movement. The spanner lock nut on the clutch shaft should be adjusted to eliminate end play without binding.

Under certain conditions, the servo may go to an address, fail to null, and remain in a state of oscillation near the address. This condition may cause the clutches to seize, causing severe wear to the drive motor pinion. Several conditions may cause this problem.

The present file servo was designed to run at or below a maximum access time (measured from pick of the start 1 relay to pick of the arrival relay on 9999 to 00999) of 750 ms (min) to 800 ms (max). If damping pots are set for a faster maximum access, oscillation may occur. Another factor entering into the problem is low cable tension. Occasionally, an unbalanced cable pair is found which may cause this difficulty in particular access locations. Still another factor that can cause this problem is a loose tachometer coupling. However, the coupling may not appear to be loose; check it thoroughly.

Wrong Reading

This can be general in nature or localized to a specific spot or area on a disk. Investigation of numerous records should indicate the type of trouble although it should be remembered that even a general malfunction will at times confine its failing to a specific area or condition. Specific spot failures can indicate the need for disk cleaning or possible replacement.

Apparent wrong reading can easily come from improper writing and this possibility should be kept in mind. If the record is known to be written correctly and read failures persist, there are four areas to investigate: (a) head to disk clearance and orientation over the track; (b) operation of the read amplifier; (c) operation of the automatic gain control circuit; and (d) selection of the wrong track.

Weak Signals. Weak signals can come from amplifier trouble or from excess clearance between head and disk owing to maladjustment of the head springs, sticking pistons, or binds. These adjustments and checks should be carefully made as they are delicate and important.

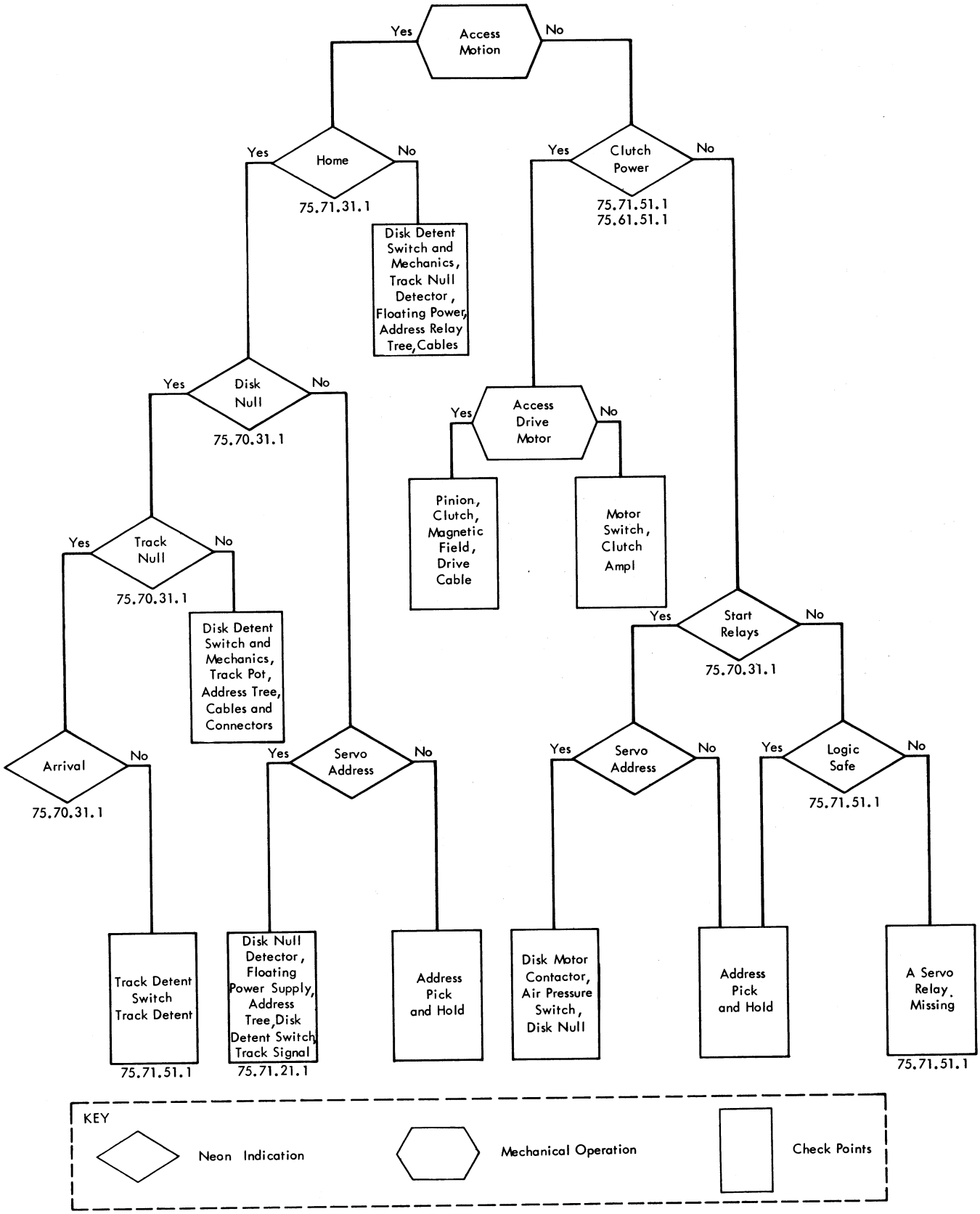


Figure 2-1. Diagnostic Flow Chart for Access Failures

WARNING: When scoping the read amplifier, do not probe any nearer the head than the input to the preamplifier on 75.62.11.1 unless absolutely unavoidable because of the very real danger of burning out a head coil or of erasing a record by a slip of the probe.

A worthwhile procedure for reference is to write mixed data on all sectors (top and bottom) of both CE tracks (inner and outer) of some disk least likely to be worked with, such as number 26. This is to be done on installation or when the machine is known to be in excellent condition. As long as these CE records are left undisturbed, a reference signal will be available. Taking peak-to-peak voltage readings and recording them can provide helpful data for future analysis.

Intermittent Read or Write Failure. Intermittent read or write failures can be caused by breaks in the coiled access arm cable or the flat elevator cable. Wiggling and jostling these cables while running the machine in a program repeat condition will provide a convenient check for continuity.

Wrong Writing

Writing troubles should show up on read back check operations and be indicated as parity or wrong length record. Some marginal conditions can put mildly defective data on the disks that will show up only on later reading operations. A check should be made, as with reading failures, to see if failures appear to be general or localized.

The read back check operation entails the reading circuits; therefore, the reading circuits can cause read back checks. Reading the signal level and waveforms in the failing area and comparing these with data previously written and known to be correct can prove valuable.

Head Elements. A few facts about the head elements may prove helpful.

1. A head with an open erase coil cannot be selected for reading or writing.
2. Any resistance buildup in the center leg can cause incomplete erasing and weak writing.
3. A record can be erased or a head burned out by careless probing in the circuits connected to the heads.

Write Driver Circuit Checking (Figure 2-2). Checking the write driver circuits can be done by scoping the circuits while writing and comparing the waveform to those on Figure 2-2.

If the waveforms appear to be satisfactory and writing trouble persists, mechanical conditions should be checked.

Known Causes of Machine Trouble

The following information is supplied to assist the Customer Engineer in the analysis of machine failures. While it is recognized that many other causes can produce similar failures, the following items have been known to cause the trouble in some instances.

Access Interlocks

Sluggish Accessing/Failure to Null.

1. Disk detent switch dirty or out of adjustment.
2. Electronics adjustments out.
3. Worn pinion.
4. Cable tension out.
5. Bind in access arm.
6. No horizontal movement of clutch shaft when pinion is disengaged.
7. Short or open address relay network.
8. Tachometer coupling loose.
9. Low air pressure.

Chattering or Double Detenting.

1. Electronics adjustments out.
2. Track potentiometer not linear (maximum error $\pm$ .38 v).
3. Track detent switch out of adjustment.
4. Warped arm.
5. Tachometer coupling loose.
6. Worn pinion.
7. Loose rotor on magnetic clutch.

Disk Storage Read or Write

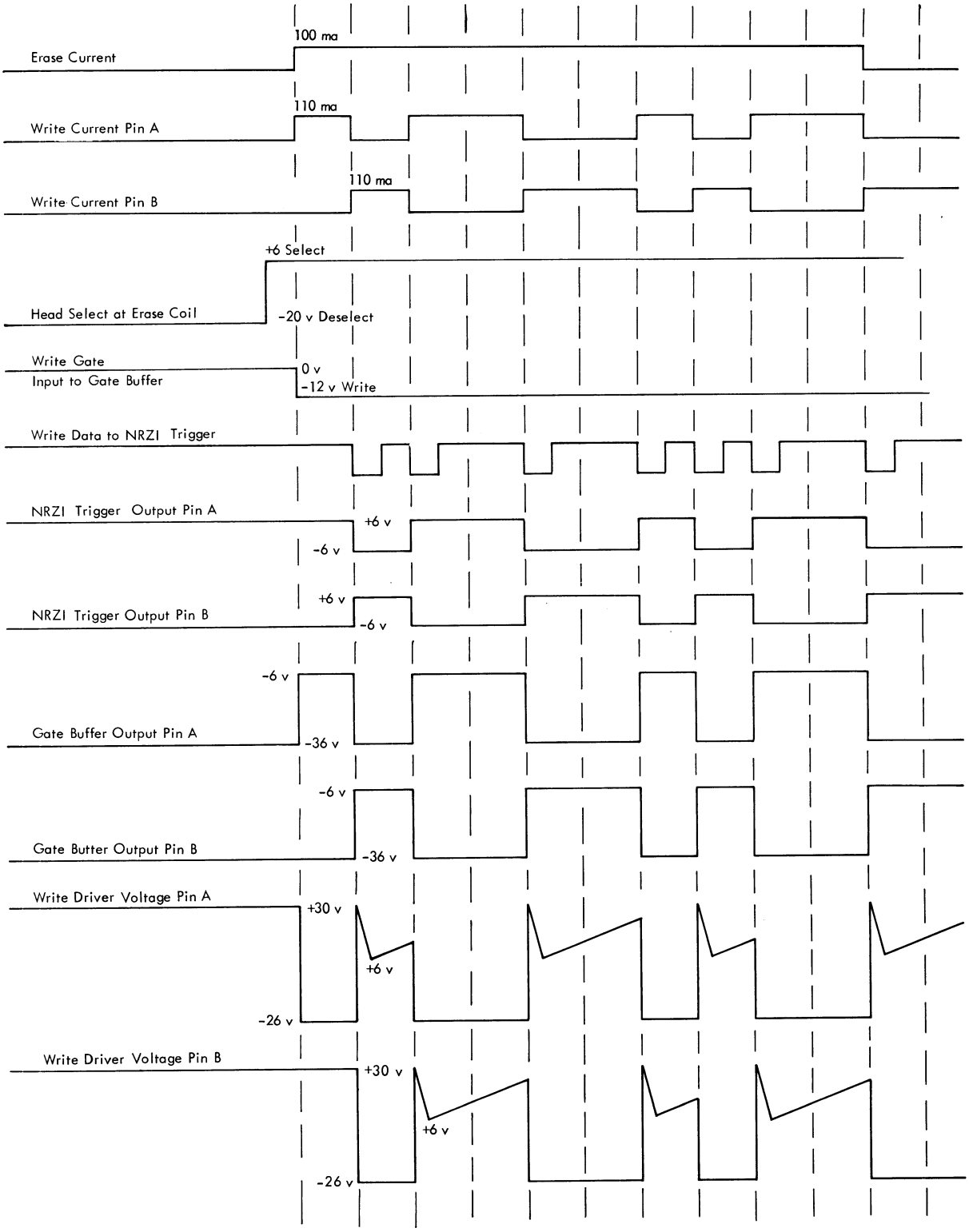
Disk Storage Parities.

1. Intermittent opening in access arm cable.
2. Track detent switch dirty or out of adjustment.
3. Oscillators out of adjustment.
4. Poor record start pulse.
5. PM on heads overdue.
6. Low air pressure.
7. Bouncing clutch brushes.
8. Bad cable plugs.
9. Worn air hose or cocked head.
10. Sticking pistons.
11. Arrival relay bouncing burned points.

Compressor

Low Air Pressure.

1. Intake and exhaust valves defective.
2. Defective auto water drain.
3. Leaking connections.
4. Safety-valve ball seal defective.



Idealized Voltage and Current Waveforms for Write Driver Circuit

Figure 2-2. Write Sequence

Section 3 Servicing Procedures

Contents

Access Mechanism

CAUTION: Remove disk storage power before starting removal and adjustment procedures. Do not operate access motor when access is disengaged from disk array.

Access Mechanism as an Assembly

WARNING: Before installing the tilt-down mechanism on the access, the safety shield over the clutch current-limiting resistor must be removed.

Removal and Replacement (Figure 3-1)

WARNING: On multiple access files remove the access side shield before removal or replacement of the access mechanism. Do not bump arm when removing access mechanism. Use the following step-by-step procedure for removal and replacement.

1. Visually check and record arm-to-disk ratio of disks 00-24-98 (Figure 3-2) with arm at track 00 and 199. These recordings will be used in the reassembly procedure. Lock arm in home position and lower carriage to lower crash stop position. Engage trolley at top of access assembly with trolley rail and adjust nut finger tight.
2. Loosen four mounting bolts which hold access mechanism assembly to disk array.
3. Tighten large nut on trolley king pin so as to just lift the access assembly from the disk array.
4. Pull access assembly away from disk array. It can now be rotated on the trolley king pin for easy servicing.

CAUTION: This unit is heavy and should be handled with care.

To tilt out the access assembly, disconnect utility connector to access motor. Disconnect four connectors at top of back plate. Disconnect air hose from frame or manifold. Rotate trolley to clear trolley rails.

WARNING: Do not rest on arm.

Rotate top of access out and down and rest on access support rod.

To replace access mechanism, reverse the removal procedure and check the arm-to-disk clearances. They should be the same as they were before removal of the unit.

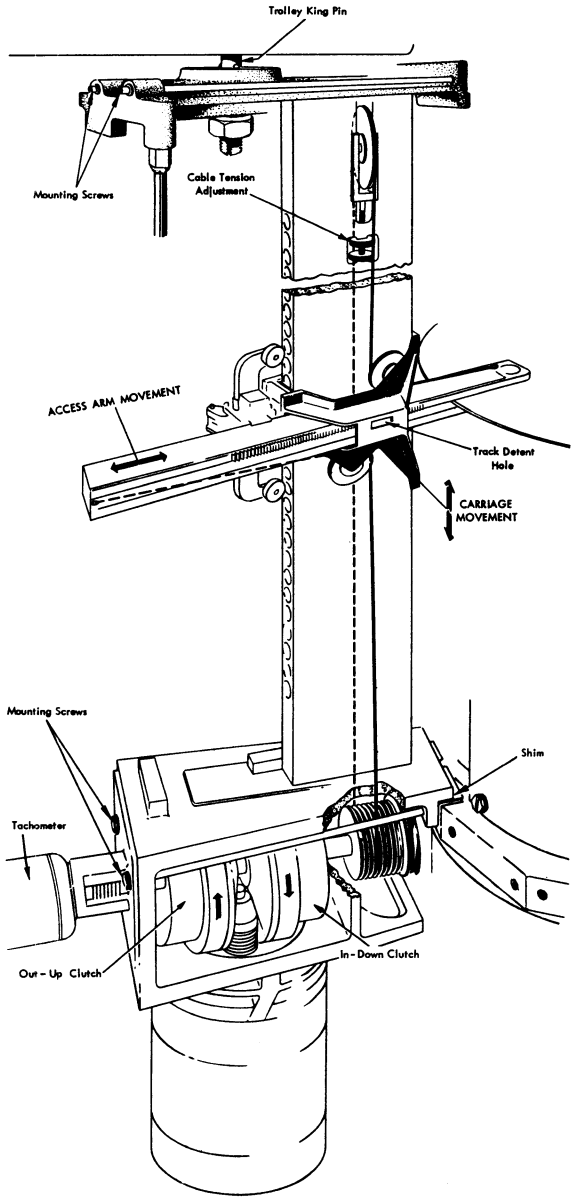


Figure 3-1. Access Mechanism

Adjustment (Figure 3-2)

Visually check the arm-to-disk clearance with the arm in the home position and at track 199. These are factory set clearances and should not be changed unless replacement of parts makes it necessary.

CAUTION: Rotate disk array only by the bottom disk.

Engage disk detent with air and move arm to an inner track address, checking for arm-to-disk clearance by rotating the disk array by hand.

Observe runout (Figure 3-2). The highpoint on the disk with maximum upward runout is +.010" from the horizontal. The low point on the disk with maximum downward runout is – .030" from the horizontal. The high point to low point should not exceed .030". If either of the above checks reveals interference or discrepancies from the limits shown in Figure 3-2, look for improper mounting of the access mechanism, a warped arm, warped disks, or other faulty components.

If a new access mechanism is being installed, it may be necessary to add or remove shims to position the mechanism for proper access arm-to-disk alignment (Figures 3-1 and 3-2). Shims can be peeled off in .003 inch sections, if there are too many. With the arm at track 199, the ideal adjustment will be A = B. The ideal clearance ratio at the inner track of the disk should be C = 4 and D = 6. Wiggle the arm gently to account for freedom of the arm in the carriage. If the clearance ratio of C or D is less than 3/7, the access mechanism will have to be shimmed upward. Dimensions at E and F should be no less than those of C and D. The G/H clearance ratio between the head covers and the disks should not be less than that of A/B.

Airfoil Assembly

The access assembly must be removed before the airfoil can be removed.

Removal and Replacement Procedures

Remove two bolts that hold foil assembly to the disk array. Use care to avoid damaging the disks. Rotate airfoils counterclockwise, looking down on the assembly, using the access assembly locating dowel pin as a pivot. Do not lose shims at bottom of airfoil assembly. When the airfoils clear disks, lift assembly away. To replace the airfoil assembly, reverse the removal procedure. Check airfoil-to-disk clearance on each access.

Adjustment (Figure 3-3)

Adjust the airfoil assembly before installing the access assembly.

The high disk is marked on its edge by one long black stripe followed by two short stripes. The low disk is marked by a single black stripe.

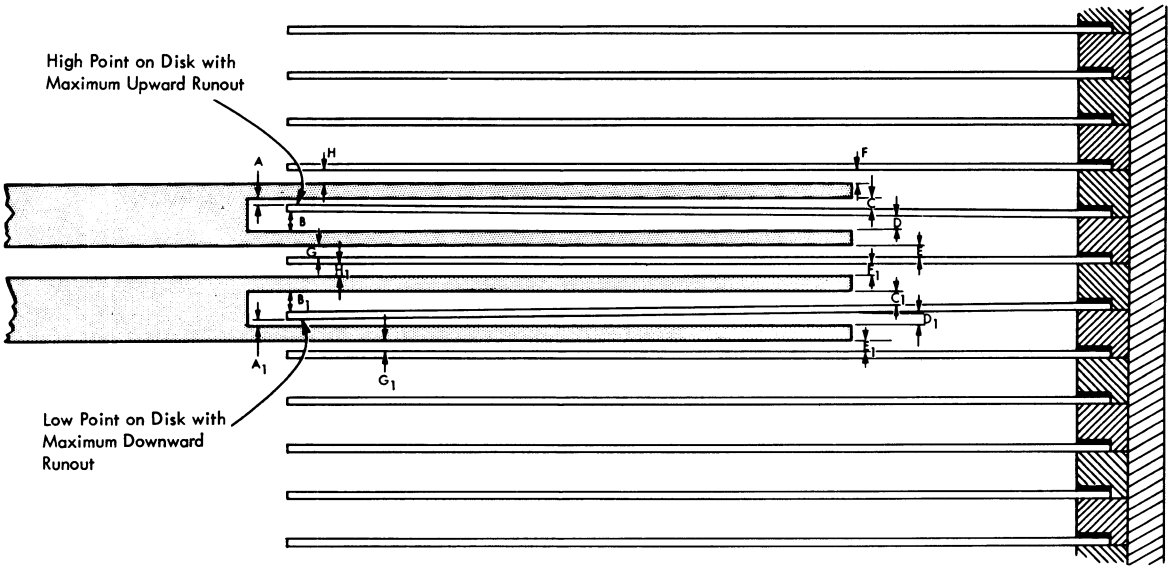
1. Rotate the disk array by hand using the bottom disk. Determine the clearance (X) between the highest disk and the airfoil above.
2. Determine the clearance (Y) between the lowest disk and the airfoil below.
3. Clearance X should be .010" ±.004" greater than clearance Y. Move airfoil assembly up or down by increasing or decreasing the thickness of the laminated shim (P/N 2109474) between the base casting and the airfoil assembly.

Way

Replace entire access mechanism assembly, if this part is not usable. See REMOVAL AND ADJUSTMENTS under ACCESS MECHANISM AS AN ASSEMBLY.

Adjustment — Access Way Vertical Alignment

This adjustment is designed to allow alignment of access vertical ways on multiple access files. It should be followed when the access assembly on any disk storage unit is replaced. Before starting this adjustment, be certain that the access is aligned to obtain maximum signal on the bottom



NOTE: High disk is marked on its edge by one long black stripe followed by two short stripes. The low disk is marked by a single black stripe.

IDEAL CLEARANCES	LIMITS
A/B = 5/5	A/B & A1/B1 = 2/8
C/D = 4/6	C/D & C1/D1 = 3/7
E/F = 4/6	E/F & E1/F1 = 3/7
G/H = 5/5	G/H & G1/H1 = 2/8

Figure 3-2. Arm-to-Disk Clearance

disk. Follow the access detent alignment adjustment to do this, then use the following step-by-step procedure:

1. Servo to inside CE track of top disk.
2. Measure top head signal. Drop track detent and manually position arm to obtain peak signal. Note amplitude difference of signals and the direction the arm was moved to obtain peak signal.
3. Servo to middle disk, inner CE track.
4. Repeat Step 2.
5. If the arm was moved in one direction to obtain the peak signals in Items 2 and 4 and the signals were linear, this indicates the access way is tilted. Follow Steps 6, 7 and 8. If the signals were not linear, add the two differences (top and the center) and take the average of the two signals (i.e., if top peak signal = +4 and center = −1, the arm will have to be moved +2½″ in Item 7).

   NOTE: It is possible to get a very strong signal from one disk. If this happens, you may have to try several disks to arrive at an average.

6. Loosen two screws at top of way just enough to allow movement of way with adjusting screw.
7. Move top of way in or out until correct signal (determined in Item 5) is obtained from top disk. Arm-to-disk clearance must be maintained during this adjustment.
8. Tighten two screws at top of way to lock this adjustment. Check scope reading.

Service Check

Clean and apply a light film of IBM #6 oil on the detent and "V" surfaces. Do not allow oil to spread to potentiometer strip; faulty servo operation will result.

Access Drive Cable

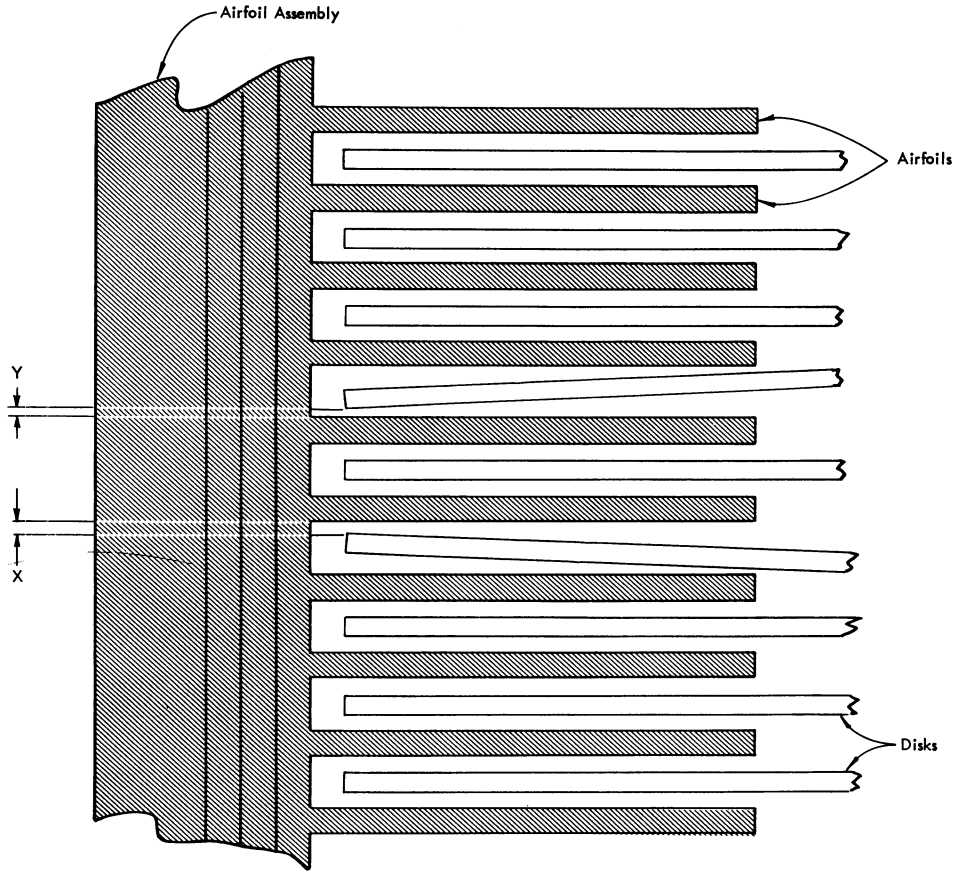
Removal and Replacement

Use the following step-by-step procedure:

CAUTION: Remove AC and DC disk storage power.

WARNING: Apply hand pressure to track detent housing or carriage to move carriage along way. Do not push on arm or use drive cables.

1. Move arm to its home position and move carriage near center of way.
2. Fully release take-up pulley to provide slack in top cable.
3. Slip top head cover out to expose cable end (it may be necessary to move the arm toward the disk about ½″). Do not remove head cover completely or head will pop up and pistons may drop out.
4. Remove cable end from top arm and slide head cover back into position to retain the head.
5. Remove bottom cable from rear of arm.
6. Remove cables from carriage pulleys and take-up pulley. It may be necessary to loosen the eccentric



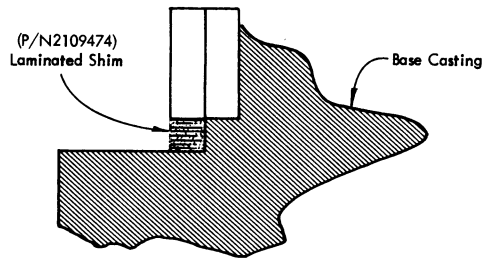


Figure 3-3. Airfoil Adjustment

adjusting bolts and reposition the carriage pulleys to provide clearance to remove the cable ends.

7. Remove cables from capstan by unwinding them and removing their anchor pins.

To replace, use the following procedure:

WARNING: The drive cable should never pass under any portion of the head lifter spring.

1. These are matched cables, therefore both must be replaced if either is bad.
2. Check to ensure that carriage is near the mid-point on the way.
3. Balance the number of turns on each cable on capstan and assembly, using the reverse of removal procedure.
4. Attach cable ends to access arm and adjust pulley eccentric adjusting screws (if they were changed in Step 7 of REMOVAL) for best vertical cable alignment and parallel alignment of cable to arm. Move arm back and forth to check for pulley-to-arm head-screw clearance. Tighten locknuts.
5. Check clearance of lower pulley to lower overtravel crash stop, with the carriage at the lowest point of travel.
6. Adjust take-up pulley for proper cable tension (Step 3 under ADJUSTMENT).

Adjustment

1. Position carriage pulleys for best possible vertical cable alignment and parallel alignment of cable to arm. Move arm back and forth to check for pulley-to-screw-head clearance.
2. Check lower pulley for clearance to the lower over-travel stop.
3. With the carriage mid-point on the way, turn lower adjusting nut finger tight. Check for slack when carriage is at extreme disk position (00 and 49). Tension with the carriage at extreme positions should range from 100 to 200 grams for ¼" cable deflection when measured at mid-point of way, on the disk potentiometer side. When checking tension, the disk should be engaged and the arm should be fully in on the disk.
4. Lock pulley in place with upper adjustment nut.

Access Arm

Removal and Replacement

CAUTION: Remove AC and DC disk storage power.

WARNING: Use care when working in the vicinity of the arm. It is delicate and easily bent.

1. Remove transparent shield.
2. Visually check arm-to-disk clearance at disk 00, 25 and 49; tracks 00 and 199. This clearance should be the same after reassembly. Make sure the disk detent is fully seated.
3. Move carriage to mid-point on way and move arm to track 199. This will minimize the chance of bending the arm during removal of the connector plug.
4. Remove two screws that fasten subminiature connector plug (end of coiled cable) to arm, and separate connector.
5. Remove air line from arm.
6. Move arm to home position and scribe a reference timing mark on potentiometer gear, before disengaging it, to facilitate reassembly.
7. Loosen track potentiometer anchor and pivot screws and rotate assembly to disengage gear (Figure 3-4).
8. With arm in home position, tape top and bottom cables to way to prevent them from unwrapping on capstan. (Do not put tape on bearing surfaces of way. Gum that remains after tape is removed may cause binds.)
9. Fully release take-up pulley to provide slack in top cable.
10. Slide top head cover out to expose cable end. (Loosen tape and move arm toward disk approximately ½", if necessary.) Do not remove head cover completely or head will pop up and pistons may drop out.
11. Remove top cable end from arm, and slide head cover back into position to retain head.
12. Remove bottom cable from rear of arm.
13. It may be necessary to loosen both top and bottom eccentrics on pulleys to allow clearance to arm (Figure 3-4).
14. Rotate arm crash stop latch 90° (Figure 3-4).
15. Pull arm out from carriage. Use caution to prevent cable ends from jamming between the arm and carriage.
16. Install special arm holder assembly (P/N 2102078) on arm before working on it.

To replace, use the following procedure:

1. Remove special arm holder assembly.
2. Carefully push arm into carriage until forward edge of fail-safe strip registers against the disk detent interlock.
3. Depress disk detent piston and move arm forward so interlock can register against side of fail-safe strip. Use caution to keep cable ends from jamming arm. If difficulty is encountered in sliding the arm into the guides, it may be necessary to back off the arm roller or the arm guide shoe or both. Do not force arm into guides (see CARRIAGE ADJUSTMENTS for arm roller and guide shoe adjustment).
4. Rotate arm crash stop into interference position and then pull arm back to home position. The access arm crash stop latch should be depressed .000" to .005" before the interlock is pushed into the interlock position. Adjust, if necessary (CARRIAGE ADJUSTMENTS).
5. Attach cable ends and rotate carriage pulleys into arm for best possible vertical cable alignment and parallel alignment of the cable to the arm.

   WARNING: The drive cable should never pass under any portion of the head lifter spring.

6. Move the arm back and forth to check for pulley-to-arm screw-head clearance. Tighten locknuts.
7. Remove tape from cables and clean off any sticky gum that may have adhered to bearing surfaces of way.
8. Adjust take-up pulley for proper cable tension. Be sure that cable ends are fastened properly.
9. Align home reference timing marks and engage potentiometer gear. Fasten assembly so there will be about .002" backlash (slight wink) between gear and rack. Move arm through entire stroke and check for any gear to rack interference or more than .002" backlash. Tighten holding screws and recheck.

   WARNING: Do not overtighten holding screws; the connector might break.

Move arm to track position 199; connect subminiature connector. Tighten its holding screw.

Connect air lines, check access mechanism adjustment, and replace transparent shield.

Adjustment

1. Check arm for freedom of motion and interlock action. Adjust arm roller, guide shoe, and interlock, if necessary (see CARRIAGE ADJUSTMENTS).
2. Check cable tension (see CABLE ADJUSTMENTS).
3. To visually check arm-to-disk clearance, use the following procedure:
   a. Move arm from home position to track 199 at disks 00 and 99 and check for arm-to-disk clearance. It should be the same as it was before arm removal. If proper clearance does not exist, check assembly procedure for possible errors, then correct them.
   b. Set up a program to servo to address 01990 and then to address 99990.

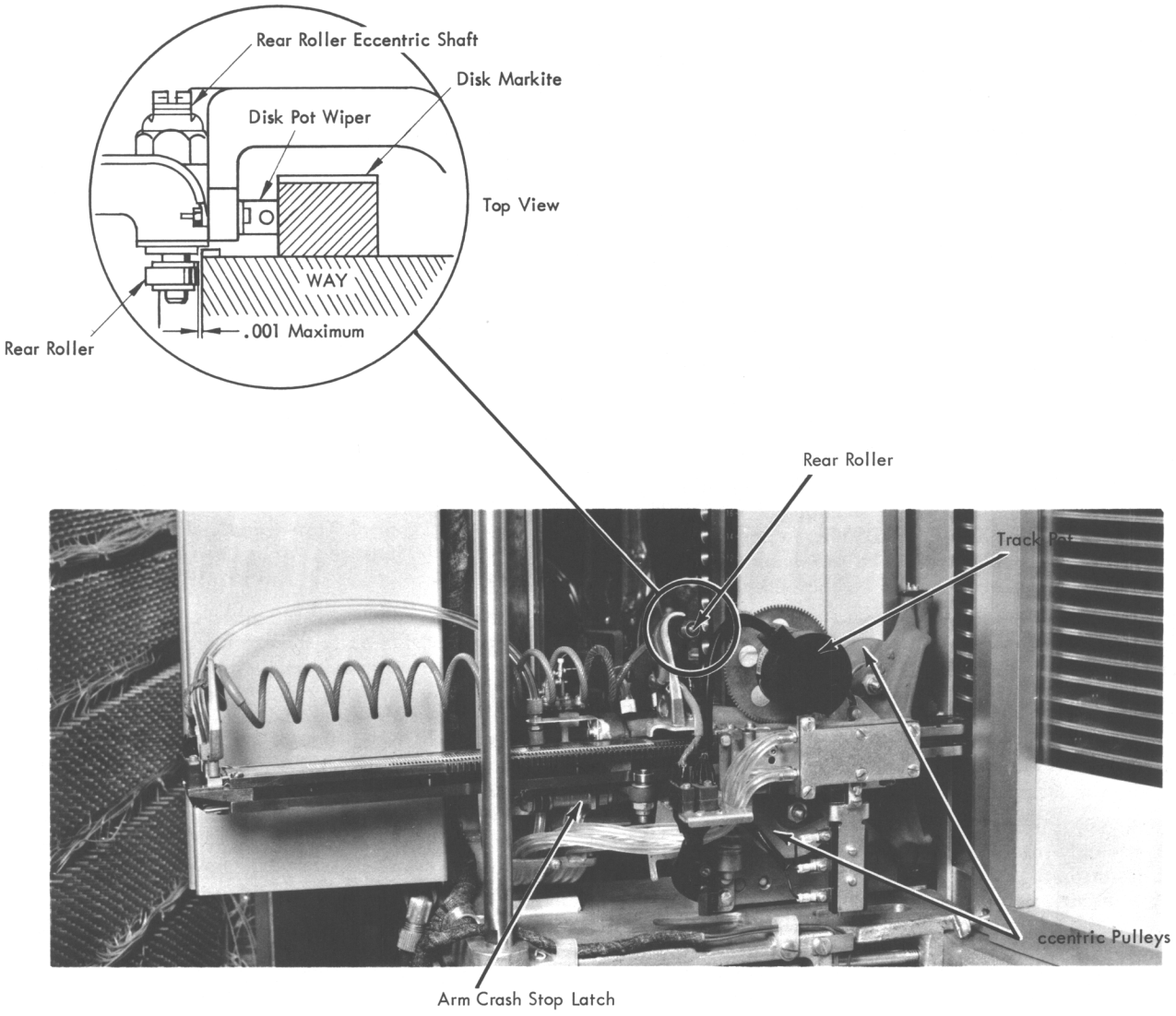


Figure 3-4. Access Arm and Carriage Assembly (Side)

c. Leave the access motor off. Apply AC and DC disk storage power.
d. Initiate the first servo operation. Rotate clutch disk manually to servo arm to address 01990. Check for arm-to-disk clearance.
e. Initiate the second servo instruction. Rotate clutch disk manually to servo arm to address 99990. Check for proper operation. The clearances should be the same as they were before removal. If proper clearance does not exist, follow the arm-to-disk clearance adjustment.
f. Check to see that the arm is on the right track by servoing to a specific track. Read from the track and check to see that the addresses compare.
g. If a new access arm is being installed, perform the ACCESS UNIT ALIGNMENT adjustments.

WARNING: Do not start access motor until all interference has been eliminated.

Heads

Removal

WARNING: Do not use lubricants on heads. Remove head spring when installing and removing head plug. Plug must lie flat in arm. Adjust plug and pigtail in arm for freedom of head in socket. Purge auxiliary air lines (P/N 2108006) prior to cleaning heads.

NOTE: This procedure can be followed by removing the access mechanism as an assembly, or by tilting the access mechanism out utilizing the tilt out bar. Service one head at a time, using the following procedure:

1. Remove access mechanism (see REMOVAL under ACCESS MECHANISM).
2. Move arm forward so heads become accessible. Place head holder (P/N 2102078) over arm to prevent damage to arm while servicing heads.

3. Remove air hose from coupling at carriage bracket.
4. Remove head cover. Care should be taken to prevent heads from popping up as pistons could drop out.

   NOTE: When the head cover is removed, the head should be depressed sufficiently to assure that the pistons clear the recess in the head cover.

5. Remove pistons.
6. Flex head spring to remove from gimbals and allow heads to be supported by air tubing and pigtail.
7. Replace head tubing, if it is damaged or excessively bowed. If it becomes necessary to remove and replace the plastic tubing, the following procedure should be used:
   a. Remove head spring and head plug from arm.

   WARNING: Do not try to push or pull tubing from nipple. Use care to avoid scoring the nipple shoulder and shank.

   b. To remove and adjust head tubing, cut through head tubing just behind shoulder of nipple. Use plastic tube tool (P/N 2108305) to remove tubing. The tubing that remains on the shank can be split off. Be careful not to score the shank in removing tubing.

NOTE: With tubing removed, replace the head springs temporarily and adjust as follows: The head lifter spring should rest evenly on the arm at the four points labeled "A" (Figure 3-5). This is to prevent a rocking action when air is applied or removed. Adjust by forming head lifter springs at points labeled "B" (Figure 3-5). However, spring replacement is recommended if possible.

Install new tubing. To prevent damage to nipple and shank, use only plastic tube tool (P/N 2108305) to install and adjust tubing. If the plastic tubing has a curl, adjust the tubing so it curves away from straddling disk and in a plane vertical to disk. Adjust head so that in its free position the gimbal pin axis is parallel to horizontal plane of arm. Replace head plug and spring in arm; do not put spring into gimbal pins at this time. Perform steps under ADJUSTMENT AND SERVICE CHECKS.

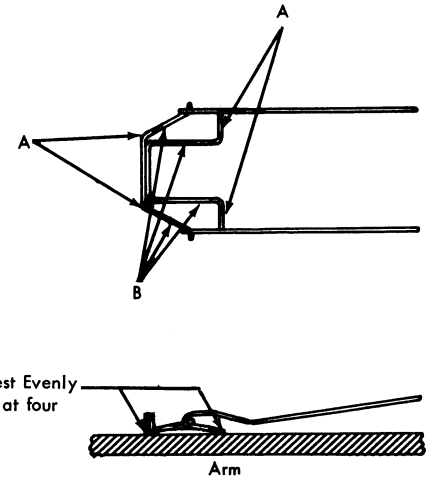


Figure 3-5. Head Lifter Springs

WARNING: Ends of head spring must be fully seated in holes in arm. Failure to seat them allows spring to rise and damage disk.

Adjustment and Service Checks

WARNING: Absolute cleanliness is essential in this area. Use only isopropyl alcohol (70% or better by volume) as a cleaning agent. Alcohol may be purchased locally. Do not reuse alcohol.

1. Brush off heads and clean air orifices with .005" piano wire. Stone wire slightly round on end. Clean the .0465" air escape hole with #56 drill.
2. Clean piston holes by flushing with alcohol (isopropyl 70% or better by volume) using small eyedropper. Blow out excess alcohol, using compressed air through air connection at carriage.

   NOTE: Air can be obtained by connecting the auxiliary air line to the arm. Put Disk Storage Unit and compressor on local control. Turn access motors off and depress Compressor Start key. Air is controlled by operating valve.

3. Test the cleanliness of the air escape orifices by supplying 50 psi of air to the carriage inlet. Hold a .003" feeler gage over each hole while blocking piston orifices; the exhaust of air should deflect the gage. Brush and clean head sockets and head covers.
4. Wash each pin in alcohol and wipe dry with tissue (P/N 2108036). Insert pistons in air heads (using tweezers P/N 2108014) and check for freedom of action. Be careful not to use any additional closing force on the tweezers. Damage to the nylatron pistons can easily result.
5. Use the gram gage and gram gage adapter (P/N 2108032) to check for proper tension of the head lifter springs. Total tension of both head springs should be 25 grams (+10 −0) equally distributed between both springs when depressed to the mid-point of the spring groove. Each spring should be 12.5 to 17.5 grams, the difference between the pairs being not greater than two grams. Adjustment can be made by forming spring 1½" from end. When the tension is correct, install the head springs in the gimbal pins and replace head cover.

   Check to see that head spring on upper head is installed so upper drive cable is above and passes completely over spring. The drive cable should never pass under any portion of the head spring.
6. Check heads for freedom of action. Using the gram gage, through center hole of head cover, perpendicular to top surface of head, check force required to just move head. This force should equal the total spring tension of the head being tested. Should the head be restricted in the arm socket, adjust length of air tubing, and/or pigtail, and plug in arm, for optimum freedom. If it is necessary to alter the position of the tubing, use the plastic tube tool.
7. Repeat Steps 1 through 6 for second head.
8. Check gimbal action and air bearing when both heads are depressed on the .100" test plate (P/N 2108024) with 50 psi of air.
9. Make sure head cover retaining springs are locked in place.

10. Thoroughly clean access arm with a brush. Remove arm holder (P/N 2102078) and return arm to home position.
11. Replace access mechanism.

Carriage (Figures 3-4 and 3-6)

Removal and Replacement

CAUTION: Remove AC and DC disk storage power.

1. Move access away from disk array.
2. Remove transparent shield.
3. Remove access arm.
4. Disconnect air lines from carriage.
5. Remove two screws that fasten elevator connector to carriage. Disengage cable connector.
6. Remove carriage backplate. Take care not to damage disk potentiometer wiper.
7. Loosen locking nuts and back off two rear shoe adjusting screws.
8. Press rear shoe against carriage. Pivot carriage about "V" portion of way and remove it.

To replace the carriage assembly, press rear shoe against carriage and put "V" part of carriage on way. Pivot carriage on way until rear shoe lines up with its bearing surface. Move rear shoe to engage way. The disk Markite* strip may have to be moved to the side to put the backplate on. To complete the replacement, use the following step-by-step procedure:

1. Fasten carriage backplate. Take care not to damage disk potentiometer wiper.
2. Adjust rear shoe without applying air pressure (see REAR SHOE ADJUSTMENT).
3. Use shims to center wiper on potentiometer strip.
4. Connect elevator cable connector and tighten holding screws (see ELEVATOR CABLE INSTALLATION).
5. Connect air lines.
6. Install access arm.
7. Turn disk storage and compressor switches to local. Turn access motors off. Depress compressor Start key.

Adjustment

REAR SHOE AND REAR ROLLERS (FIGURES 3-4 AND 3-6)

1. Apply disk detent air to pull carriage against "V" portion of way (Figure 3-6).
2. Adjust upper and lower adjusting screws for a .003" maximum clearance between screws and rear shoe (Figure 3-6).
3. Adjust rear roller eccentric shafts for .001" maximum clearance between rollers and way at tightest point. Lock in place (Figure 3-4).
4. Check freedom of carriage over entire used portion of way.

CABLE TENSION

See ACCESS DRIVE CABLE — ADJUSTMENT

ARM ROLLER BEARING AND FRONT GUIDE SHOE (FIGURES 3-4 AND 3-6)

1. Fully seat disk detent and move to home position. This is necessary to eliminate interlock to arm interference.
2. Rotate roller eccentric stud for a maximum of .001" roller to arm clearance. Tighten locknut. (Figure 3-6).
3. Front Guide Shoe (Figure 3-4). Adjust arm guide shoe to .003" maximum clearance between arm and shoe as follows:
   a. Loosen two nuts on slotted adjustment screw so shoe movement is not limited during adjustment.
   b. Turn in the two adjusting screws solid against arm and then rotate them backward 10° to 20°. Arm should be free from any drag, but tight enough to prevent a .003" feeler gage from entering between arm and shoe. Lock adjustment screws with adjusting nuts.
   c. Turn inner nut (on slotted adjusting screw) to bear lightly against plate. Holding nut securely, turn outer nut to lock against it.
   d. Arm should remain free without drag.
4. Keep disk detent fully detented and move through entire stroke. Check for and remove any binds or excess play.

DISK DETENT INTERLOCK (FIGURE 3-6)

1. Arm roller and guide shoe must be properly adjusted.
2. Apply disk detent air.
3. Adjust interlock assembly, adjusting screw for .003" (±.001") clearance between interlock face and side of arm fail-safe strip at closest point. Tighten lock nuts.
4. Make sure all slack is removed from linkage points.
5. With arm at a track address and the disk detent air removed, vertical freedom of the carriage should not exceed .007" (visual).

ACCESS ARM CRASH STOP (FIGURE 3-4)

1. Turn adjusting nut to compress resilient bumpers (1 to 1.5 turns).
2. Adjust position of crash stop latch, so arm returns to home position and the tab on the other side of the arm strikes crash stop latch just before (.000" to .005") interlock slide can enter cut in arm. Remove shims as required.

Service Checks

Remove arm crash stop from mounting stud and apply a light film of IBM #20 to portion of stud on which the stop slides. Re-adjust as required.

**Trademark of the Markite Corporation, New York 14, N.Y.*

Carriage Felt Wipers

Removal and Replacement

Remove two screws that fasten wiper bracket and remove bracket and felt wiper. Replace wipers if surface becomes glazed.

To replace, put wiper in position against way and place wiper bracket on top of it. Fasten wiper down with holding screws.

Adjustment

Loosen holding screws and move felt so it contacts "V" surface on way. Tighten screws.

Carriage Overtravel Crash Stops

Removal and Replacement

Remove mounting bolts and disassemble as desired. To replace, reverse the removal procedure. Apply a light film of IBM #17 to plungers.

Adjustment

Position switch so an overtravel stop shaft movement between 1/32" and 1/16" transfers switch contacts.

Rear Shoe (Figure 3-6)

Removal and Replacement

CAUTION: Remove AC and DC disk storage power.

1. Remove carriage from way (see CARRIAGE REMOVAL).
2. Remove rear shoe.

To reassemble, reverse this procedure.

Adjustment

1. Make adjustments with access mechanism positioned on trolley track.
2. Apply disk detent air to pull carriage against "V" portion of way.
3. Adjust the two adjusting screws for a clearance of .003" maximum between screws and rear shoe (Figure 3-6).
4. Check for freedom of carriage over entire length of way.
5. Make additional adjustment necessitated by carriage removal and assembly procedure (see CARRIAGE ADJUSTMENTS).

Elevator Cable

Removal and Replacement

CAUTION: Remove disk storage power.

1. Remove upper and lower holding clamps.
2. Remove connectors at both ends of potted cable.
3. Remove cable.

To replace and adjust the elevator cable, use the following step-by-step procedure (Figure 3-7).

1. Assemble connector to backplate. The unpotted portion of the potted cable should be back of the service cable in order to prevent slack in unpotted wires from snagging the carriage during machine operation.
2. The other end of the cable assembly is connected to the carriage by means of a bracket, and the elevator cable itself terminates with two small connectors which carry the read-write circuits and the track address circuits. Care should be exercised to position the bracket, which holds the elevator cable, horizontally. The air tubes and cables must not interfere with

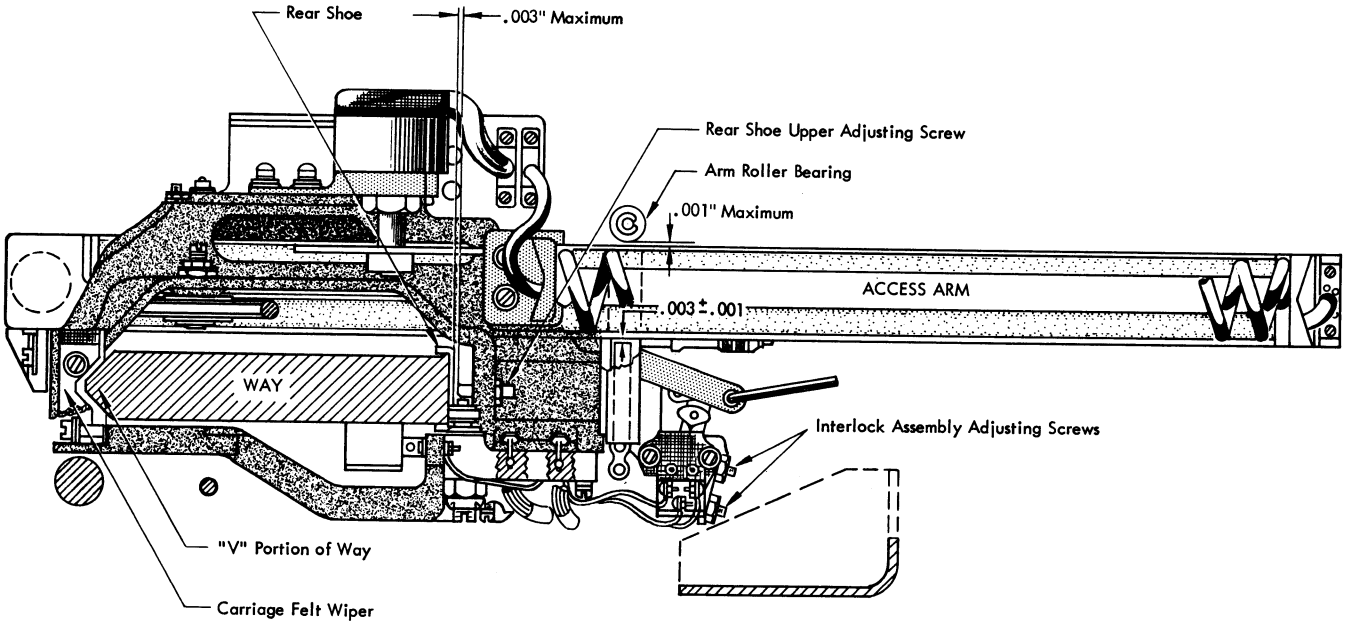


Figure 3-6. Access Arm and Carriage Assembly (Top)

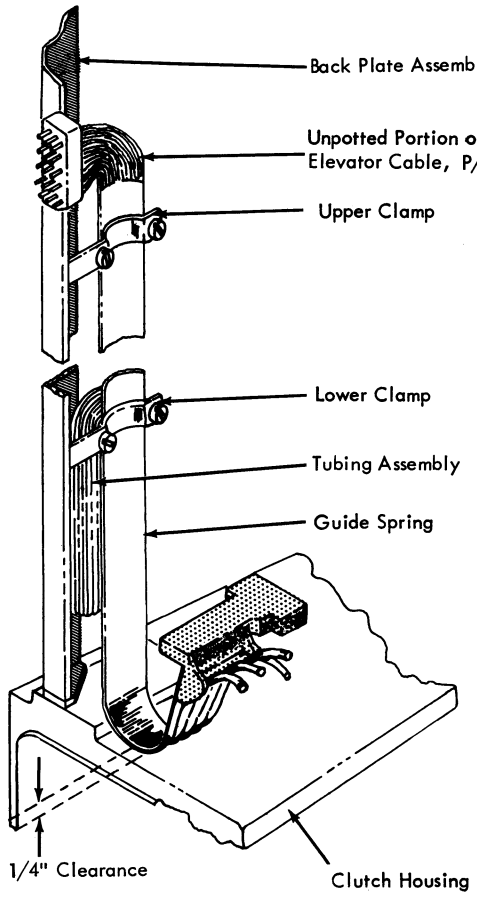


Figure 3-7. Elevator Cable

the operation of the arm and the arm crash stop.

3. Position multi-air tube assembly (extending down through the opening between the lower clamp and the back plate), cable, and guide spring together and lightly secure with upper and lower clamps so final positioning can be established.
4. The final position of the air tube assembly, elevator cable, and guide spring should be such that:
   a. The guide spring is vertical and centered on the elevator cable.
   b. The air tube assembly, elevator cable, and guide spring lie one against the other without developing slack when the carriage is servoed to disk 00 or disk 99. Check by manually operating arm and carriage.
   c. The air tubing is ⅛" to ⅜" from clutch housing when carriage is servoed to disk 99. Check by manually operating arm and carriage.
5. Tighten upper and lower clamps and check for final position and clearance of elevator cable when carriage is detented to disk 00 and moved along the carriage way from disk 00 to disk 99.

Disk Detent Assembly

Removal and Replacement

CAUTION: Remove AC and DC disk storage power.

1. Disconnect leads from disk detent switch.
2. Remove detent assembly mounting screws.
3. Remove disk detent.

To replace, follow the reverse procedure. Make adjustments, and lubricate all bearing points. Apply power, and check machine for proper operation.

Adjustment

1. Check arm roller bearing and front guide shoe adjustments (see ACCESS ARM ADJUSTMENT).
2. Set disk storage unit for local operation.
3. Apply disk storage power and start air compressor. Leave disk drive and access motors off.
4. Apply disk detent air to fully detent carriage. Adjust interlock assembly interlocking screws for a clearance of .003" (±.001") between fail-safe strip and interlock with all linkage slack removed. Check at closest point. Tighten adjusting screw lock nuts.
5. Position arm to track address and move carriage up and down to check for vertical motion. It should be .007" or less. The disk detent air should not be applied while making this check.
6. Check machine for proper operation.

Disk Detent Switch Assembly (Figure 3-8)

Removal and Replacement

CAUTION: Remove AC and DC disk storage power.

1. Remove switch mounting screws.
2. Lift switch straight up so actuator will clear drive pin.
3. Disconnect cable from switch by removing screws.

To replace, follow the reverse procedure. Make adjustments, then apply power and check for proper adjustments.

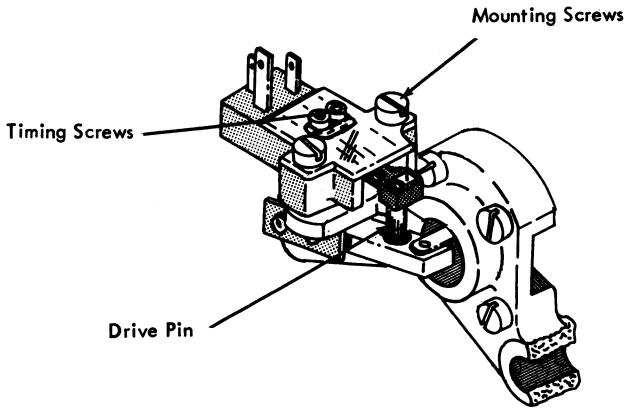


Figure 3-8. Disk Detent Switch Assembly

Adjustment

CAUTION: Turn power off before making these adjustments.

1. Set drive pin in approximate middle of its travel.
2. Align switch so actuator is centered around drive pin when the switch rests fully against raised portion of mounting surface. Tighten mounting screws.
3. Adjust timing screw so contacts are made with 1/64" overtravel when disk detent is fully seated.
4. Adjust the other timing screw so detent is fully retracted when contacts have 1/64" overtravel.
5. Operating point must break before the make.

Track Detent Assembly

WARNING: This unit determines the exact radial position of the heads with respect to the tracks on the disks and must not be removed or adjusted unless absolutely necessary.

Removal and Replacement

1. Select a disk with minimum runout, and servo to an inside track on this disk (note the address used). Turn CE test switch on. Note that a head must be selected in order to provide an input to the read amplifier.
2. Trigger scope with record start and observe read amplifier signal pin. Record this voltage.
3. Turn off access motor at convenience outlet.
4. Lock the access arm in position by tightening the front shoe.

CAUTION: Remove disk storage AC and DC power.

5. Separate track potentiometer cable assembly connector.
6. Mark track potentiometer gear and arm to facilitate reassembly.
7. Remove detent air lines.
8. Remove detent assembly adjusting screw.
9. Remove track detent switch or wires.
10. Remove (two) detent assembly mounting screws.

NOTE: On reassembly after AC and DC power have been restored, seat the same detent used on the original address. Have the adjusting screw backed off and the mounting screws loose. Tighten the mounting screws and set the adjusting screw. Readjust the front shoe. Recheck for the voltage noted in Step 2. If any discrepancy exists, make the access detent alignment adjustment. Finally, apply power and check for proper operation.

Check to be certain that the arm is actually at the address set up by the address relays.

Access Unit Alignment Adjustment

The alignment of any access to existing data on the file is outlined in the following procedure. This includes alignment of a second and third access to the first access or replacement of the first access. The procedure involves aligning the access arm on the bottom disk to a maximum signal of the proper track by adjusting the track detent assembly in or out as required. The access is aligned to the top of the disk by moving the arm in or out by rocking the top of the way by its top adjustment screw.

1. Servo the desired access to the bottom disk inside track record 0.
2. Turn off the access motor.
3. Give a read instruction and single cycle to the point where the record select lights on the FEG display panel come on (digit 6).
4. Connect the scope to read the head signal at the output of the first stage of amplification (K04-A and B).
5. Trigger the scope on record start.
6. Loosen slightly the screw holding the track detent switch to the carriage.
7. Move the detent assembly in or out as required to obtain a maximum head signal. The 0 detent should be engaged with the arm, hence moving the track detent assembly will move the arm.
8. Read the address of the track on the scope. It should be the correct one. If not, move the track detent assembly until the proper track appears on the scope.
9. Tighten the screws holding the track detent switch to the carriage. Be careful that the signal amplitude does not change. The heads should now be properly aligned to existing data on the bottom disk.
10. Servo the access to the top disk inside track record 0.
11. Be sure the access motor is off.
12. Give a read instruction and single cycle to the point where the record select lights on the FEG display panel come on (digit 6).
13. Connect the scope as in Steps 4 and 5.
14. Loosen slightly the two screws locking the way to the top casting.
15. Move the way in or out as required to obtain a maximum head signal.
16. Read the address of the track on the scope. It should be the correct one. If not, move the way until the proper track appears on the scope.
17. Tighten the screws loosened in Step 14. Be sure the head signal ampltiude does not change during this operation. The heads should now be properly aligned.
18. As a final check, turn the access motor on, servo, and read the following records:

AM019900	AM019600	AM259700	AM999800
AM019950	AM019650	AM259750	AM999850
AM019800	AM259900	AM259600	AM999700
AM019850	AM259950	AM259650	AM999750
AM019700	AM259800	AM999900	AM999600
AM019750	AM259850	AM999950	AM999650

These addresses are the inside track addresses for each detent and each head on the bottom, middle, and top disks. Ability to properly read these records is reasonable proof of proper alignment.

Service Checks

1. Check for loose parts (particularly the slotted guide pins) to see if they are worn and refer to TRACK DETENT ASSEMBLY-ADJUSTMENTS if discrepancies exist.

   WARNING: Care should be exercised when lubricating the track detents; excess oil will transfer to the arm and then to the disk and cause damage to the disk coating. If the pistons are free and there is some oil on the detent mechanism, postpone lubrication until the next inspection.

2. Remove rear cover of detent mechanism and place a drop of IBM #6 oil at top of each U-Cup Seal.

In case the detent pistons should stick during normal operation, remove pistons, clean, and lubricate as follows:

1. Remove slotted guide pins.
2. Remove piston, U-Cup Assemblies, and return springs. Be careful not to lose the guide pin lock washer or to drop it into the mechanism.
3. Clean pistons, piston guide bores, and air cylinder bores, and check for wear.
4. Apply light film of oil to pistons and air cylinder bores.
5. Reassemble pistons to their respective bores. Piston notched on U-Cup end must go back into notched air cylinder.
6. Reassemble slotted guide pins and lock washer to air pistons. Push switch actuator toward carriage so guide pins will be on proper side of actuator and will prevent damage to switch.
7. Reassemble cover and gasket.
8. Remount track detent switch, if removed, and check adjustment (see TRACK DETENT SWITCH).

Track Detent Switch (Figure 3-9)

Removal and Replacement

CAUTION: Remove AC and DC disk storage power.

1. Remove two mounting screws holding switch to track detent housing.
2. Remove screws connecting cable to switch.

To replace the track detent switch, use the following procedure:

1. Replace hair pins on switch if they have been removed.
2. Connect cable to switch, using connecting screws.
3. Mount switch on track detent housing with two mounting screws (seat switch against its registration surface). Switch actuator paddle is to be on carriage side of guide pins for proper operation.
4. Move switch actuator paddle to check for clearance with top of track detent assembly housing.
5. Adjust switch.
6. Apply power, and check machine for proper operation.

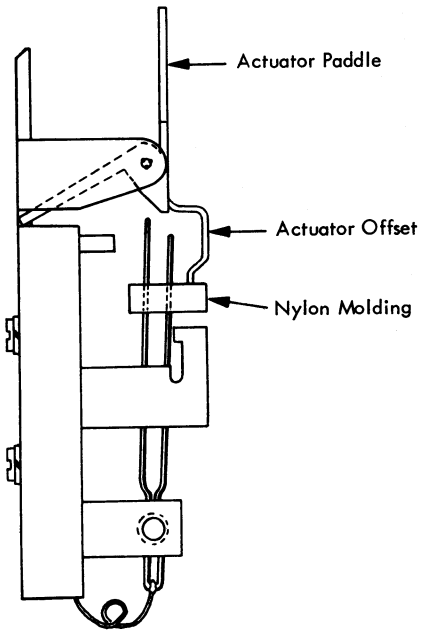


Figure 3-9. Track Detent Switch Assembly

Adjustment (Figure 3-10)

CAUTION: Turn off DC power.

1. Move switch actuator paddle to check for clearance with detent housing.
2. Connect an ohmmeter across normally open terminal and operating terminal.
3. Apply air to any track detent piston and adjust corresponding setscrew until normally open contact is just made; then turn setscrew ½ turn clockwise (see Figure 3-11). Check with arm all the way in, at the center, and all the way out.
4. Repeat Step 3 for each detent.
5. Connect ohmmeter across normally closed terminals.
6. Place a .005" feeler gage between arm teeth and any detent (Figure 3-10). Apply air. The normally closed contact should be open. If it is not open, Steps 3 and 4 were incorrectly performed or the switch is not within specifications. If the latter is the case, replace the switch.

Service Check

Check the adjustments and make certain the electrical contact surfaces are clean. Apply lubricant, IBM P/N 357830 to the actuator pivot points. Check all parts for wear and tightness. Pivot wear can change switch adjustment.

Disk Potentiometer Wiper

Removal and Replacement

CAUTION: Remove power from system and turn off access motor at convenience outlet.

1. Scribe several places around Markite bar to facilitate reassembly.
2. Remove wiper signal wire and the two mounting screws on the wiper block.
3. Remove four of the five mounting screws that hold Markite bar to way.
4. Loosen remaining screw.
5. Pivot potentiometer; wiper block will now drop down.

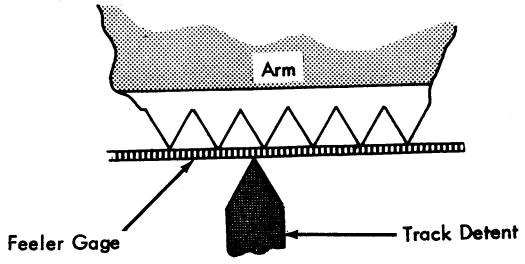


Figure 3-10. Track Detent Adjustment

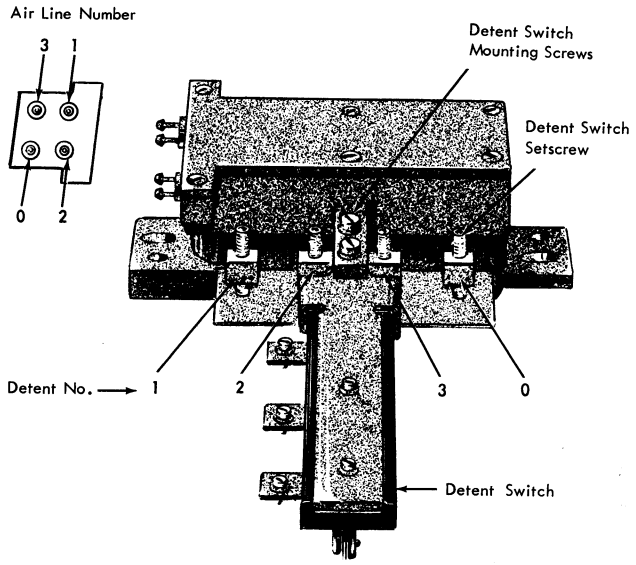


Figure 3-11. Track Detent Assembly

Adjustment

1. Turn off access motor at convenience outlet.
2. Loosen potentiometer mounting screws.
3. Set up a disk servo address.
4. Turn clutch by hand and servo to address indicated.
5. Scope disk error signal.
6. Move potentiometer bar up or down until signal on scope is at zero volts ($\pm$ 0.1 v).
7. Tighten Markite.
8. Check several disk locations.
9. Check for proper machine operation.
10. If difficulty arises, remake the access electronic adjustments.

Access Motor (Figure 3-12)

Removal and Replacement

CAUTION: Remove AC and DC disk storage power.

1. Separate access motor utility cable connector.
2. Remove four bolts that fasten access mechanism to pinion housing.
3. Remove access motor and pinion assembly. Be careful to prevent fan blade damage when removing the motor and pinion assembly.
4. Loosen setscrew that fastens pinion to motor shaft and remove hub.

To replace, use the reverse procedure.

Adjustment

Position pinion roller for proper pinion roller to clutch disk tension (see PINION ROLLER ADJUSTMENT).

Pinion Roller (Figure 3-12)

Removal and Replacement

CAUTION: Remove AC and DC disk storage power.

1. Separate access motor utility cable connector.
2. Remove four bolts that hold access motor and pinion housing to clutch housing.
3. Remove access motor and pinion assembly.
4. Remove pinion mounting screw and two washers from pinion mounting shaft.
5. The pinion roller, compression spring, and key are now free to be removed.

Replace by using these procedures in reverse. The pinion roller should be free to move axially on the shaft. Remove any binds and lubricate the shaft sparingly with special lubricant P/N 357830. Do not allow grease on pinion face. Make adjustments.

Adjustment (Figure 3-10)

1. Check for freedom of axial motion by depressing pinion roller against compression spring with a screw driver or other blunt instrument; allow spring to return pinion roller. It should operate smoothly and freely.
2. Shim pinion shaft on motor shaft to obtain a pinion roller to retaining washer clearance of $\frac{1}{32}$" ($+\frac{1}{32}$" -0"). Tighten mounting screw.

Service Checks

1. Replace pinion if it becomes cracked, pitted, or shows excessive wear.
2. Pinion roller should be free to move on shaft. A worn pinion key can restrict upward movement of the pinion.
3. Clearance between the pinion roller and its upper limit retainer should be at least $\frac{1}{64}$".
4. Lubricate pinion shaft with thin film of special lubricant P/N 357830. Do not allow grease to drop on roller drive surfaces.

Tachometer

Removal and Replacement

CAUTION: Remove AC and DC disk storage power.

1. Remove two connecting leads from tachometer.
2. Back off double setscrews that anchor flexible coupling to tachometer shaft (two setscrews in each tapped hole).
3. Remove two bolts that hold tachometer to mounting bracket.
4. Remove tachometer; be careful not to damage flexible coupling.

To install tachometer, reverse these procedures. Tighten flexible coupling setscrew against flat side of tachometer shaft and lock setscrew. Check operation.

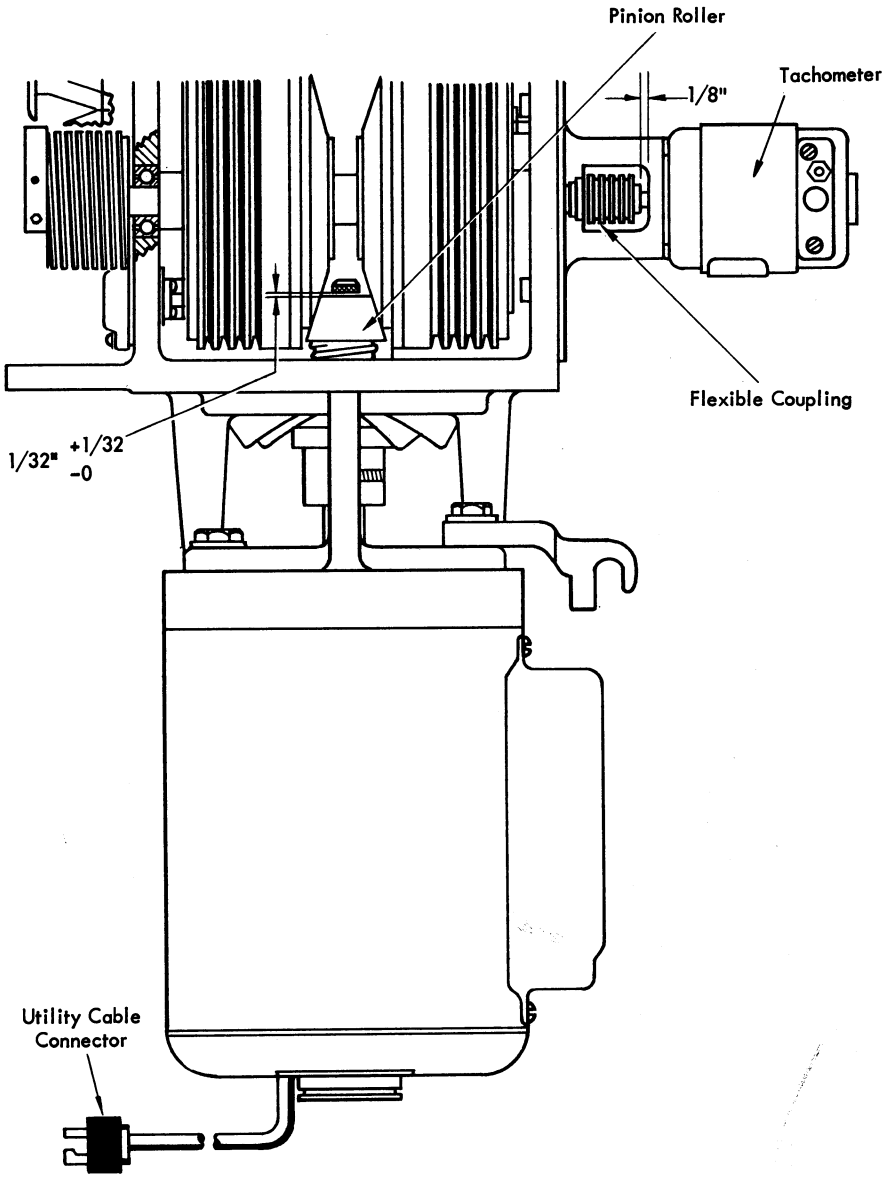


Figure 3-12. Access Motor

Adjustment

1. Manually rotate clutch shaft and check for shaft alignment and binds.
2. Check for ⅛" clearance between tachometer and coupling (Figure 3-12).
3. Apply power and servo to various addresses and check for proper operation.

Service Checks

1. Inspect brushes and replace when necessary.
2. Check setscrews on both ends of coupling for tightness (two in each tapped hole).

Magnetic Clutch

Removal and Replacement

CAUTION: Remove AC and DC disk storage power.

1. Move access assembly out on trolley.
2. Remove access motor and pinion assembly.
3. Tape cable to capstan securely.
4. Lower cable tension pulley to slack off cables.
5. Loosen capstan clamping screws and remove capstan from shaft.
6. Remove tachometer leads and slip ring leads from clutch outboard bearing flange.

7. Loosen locking screw and anchor screw at clutch end of flexible coupling.
8. Remove clutch outboard bearing flange mounting bolts.
9. Remove tachometer and bearing flange assembly.
10. Remove drive clutch assembly.

To replace, follow these procedures in reverse, making sure the tachometer coupling is secure. Make adjustments, then apply power and check for proper clutch operation.

Adjustment

1. Check pinion roller adjustment.
2. Make cable tension adjustment.
3. Check arm-to-disk clearance.
4. A tension of 100 (+10) grams should exist between the brush and the commutator.
5. Brushes should be well seated on the commutator and ride parallel to each other (sight check).
6. Clutch and shaft assembly should be free to move laterally, by hand, in the supporting bearings when the pinion drive is disengaged.

Service Checks

1. If clutch commutator is pitted or has an accumulation of dirt, clean with crocus cloth.
2. Oil the shaft with IBM #6 where it passes through bearings.
3. Check proper brush tension.

NOTE: Bearings are permanently lubricated.

Disk Array

Disk Array Shields

Removal and Replacement

CAUTION: Remove AC and DC disk storage power. Do not operate disk drive motor when disk array shields are removed.

1. Remove screws from top casting.
2. Remove screws from bottom casting except those holding center metal-aligning shield (dowelled) opposite access mechanism. This shield is used as a reference and should not be removed from the bottom casting.
3. Remove all other shields.

To replace, follow the reverse procedure.

Adjustment

Check for and correct any shield-to-disk-array interference.

Service Check

Clean off dirt and dust with IBM cleaning fluid or perchloroethylene.

Disk

Removal and Replacement

Machines shipped after February 1963 (B3 suffix) may have pre-gapped disks installed. These disks are identified by a black pen mark on each side of the scribe mark, and are normally stacked at the bottom of the array. They also have a "T" stamped on the inside non-coated area of the disk (visible only when the disk is removed from the machine). The vertical bar of the "T" is in line with the scribe mark on the outer edge of the disk.

It is essential that pre-gapped disks be realigned accurately even if the information stored on them has been read out and stored elsewhere. The top dummy disk on files with pre-gapped disks must also be realigned accurately, because it determines the position of the gaps on all data disks.

Steps in the removal and replacement procedure marked with an asterisk are to be performed only if the machine has pre-gapped disks. Field replacement disks, P/N 2130213 are not the pre-gapped type. No special precautions are necessary when installing these disks on machines with suffixes prior to B3.

NOTE: Punch all disk storage records into cards or write on tape, if practical. Disks may be removed and replaced without altering information on them if care is exercised. The customer must be informed of the risk involved in this operation. Record the signal level of disks (00), (50), and (99); also their location and scope settings.

CAUTION: Remove AC and DC disk storage power.

1. Move access mechanism out on trolley track.
2. Remove airfoils, if machine has dual access.
3. Remove shield fastening screws from top and bottom of all shields except screws at bottom of center metal aligning shield (dowelled) opposite access mechanism. This shield is used as a reference and should not be removed from the bottom casting. Remove all other shields.
4. Omit this step on machines with suffix B3 or later. The left-hand edge of the metal shield opposite the access mechanism has been set perpendicular to the base casting at the factory. The disk aligning tool (P/N 2108145) will fit on this shield. The 60° notch in the tool should be adjacent to the disks. Using this tool (without rotating the disk array), check that the scribed lines on all the disks are in the center (±.010″) of the 60° notch when the tool is slid up and down the aligning shield. If not, scribe a new line on all disks, using this 60° slot and taking care not to bend the disks or to leave burrs. Color mark a line at 20° starting at ½″ right of existing scribed line. This reference will ensure that all disks are reassembled right side up and in order.
5. Remove dust cover from top casting and seal assembly.
*6. Place Disk Aligning Tool, P/N 2108570, on the left edge of the disk array aligning shield and rotate the disk array so that the disk scribe marks are centered in the aligning gap on the aligning tool. Clamp the array in this position with Disk Clamp, P/N 2108314. Do not loosen this clamp until after the disks have been restacked and the top clamping ring is tightened.
*7. Check the alignment of the factory scribing marks using Disk Aligning Tool, P/N 2108570. All scribe marks must be within the aligning gap between the plastic blocks on the tool. This gap is .030″ wide, allowing a .015″ variation left or right of center. If any scribe marks are not within the gap, rescribe the disks using the procedure outlined in Step 8.
*8. If present scribe marks are not aligned within tolerance, rotate the array to a new area and clamp with Disk Clamp, P/N 2108314. Place the Disk Aligning Tool, P/N 2108570, on the disk array aligning shield with the scribing point above the dummy disk. Screw

in the scribing point until it projects about .020″ past the edge of the disk. Holding the tool firmly against the shield, move it down to the bottom, scribing each disk. It is not necessary to make repeated passes; one stroke will make a satisfactory scribe mark. Mark disks with a marking pencil so that the old scribe marks are not used when restacking. Be sure to retract the scribing point after scribing is completed.

NOTE: Rescribing of pre-gapped disks can be done if necessary, but the original scribe marks put on in the plant should be used if possible.

9. Remove center shaft clamping bolt and spacer, then lift top casting off.
10. Remove six Allen head screws, holding disk clamping ring, and lift clamping ring off vertically, taking care not to damage the shaft threads.

WARNING: Use extreme care to prevent scratching the recording surface and deforming the disk. Never lift the disk until the spacer above it has first been removed.

11. Remove top disk spacer. If the spacer should adhere to the disk below it, free it as follows:
Insert pin that protrudes from handle of disk installation tool into groove located in outer diameter of disk spacer. Lift toe of tool until head of handle that pivots about the pin bears against the disk and forces spacer and disk apart.
12. Remove top dummy disk. Insert shoe of disk installation tool between disk inner diameter and rotating shaft and adjacent to one of the blocks. The rounded corners on the shoe must be against the disk. Turn handle until toe of tool bears against rotating shaft and forces disk away from the block by compressing the centering ring slightly. Lift disk off block while tool holds them apart.
13. Remove balance of disks and spacers, one at a time, until the disk to be replaced is reached. Reassemble disks and spacers right side up on a table, keeping them in order. Do not reassemble disks and spacers upside down on table.

To replace, use the following procedure:

NOTE: The high point of the rotating shaft has been marked and the dummy disk must be installed so that the scribed line is lined up with this mark. The scribed mark on the first spacer must also be lined up with this mark.

1. Install a disk as follows: (See Step 4 for machines with suffix B3 or later.)
Check that centering spring on spacer is installed clockwise from pin, when viewed from top. Place disk on top of spacer in such a manner that the inside diameter includes centering spring and one locating block. The edge of the inner diameter of the disk should rest on the top of the remaining locating block.
If there is a scribed line on the outer edge of the disk, rotate assembly until mark is approximately lined up with center of 60° slot in disk aligning tool or with edge of aligning shield. If no scribed line is present, rotate disks until scribed disk number on clamping surface is approximately adjacent to centering spring. Check to see that the colored mark is to the right of the scribed mark. Insert shoe of disk installation tool into gap between disk inner diameter and rotating shaft, and adjacent to unseated locating block. The rounded corners of the shoe must be against the disk.
Turn handle until toe of tool bears against rotating shaft and draws disk over by compressing centering spring slightly. Press disk down over block. Use care to prevent overstressing of the centering spring. Press down lightly around inner diameter to assure that disk is properly seated. Replace any centering spring that does not keep the disk against the blocks, and the blocks against the rotating shaft. If there is a scribed line on the outer edge of the disk, rotate disk until mark is lined up within .010″ to center of 60° slot in disk aligning tool. Scribe a line on edge of disk if none is present.
2. Install the spacers as follows:
Slip spacer down rotating shaft. Rotate spacer until slots in spacer meet with locating blocks and centering spring of spacer below, and the spacer drops down into place. (When viewed from above, the centering spring of the spacer locates 107.5° counterclockwise from the centering spring of the spacer below.)
Check that spacer is properly seated and locating blocks are resting properly against rotating shaft. If a block becomes dislodged from the spacer, it must be replaced so that the curved portion touches the disk.
3. Replace remaining disks and spacers in the exact order they were removed. Rotate each individual disk, as it is replaced, until disk and spacer are oriented approximately as they were, and the scribed line of the edge of the disk is lined up within .010″ to the center of the 60° slot in the disk aligning tool.

NOTE: The spacer directly beneath the clamping ring has no locating blocks, pins, or centering spring. Also, the spacer located between the top dummy disk and disk number 99 is .060″ thicker than normal spacers.

*4. When restacking disks using the Disk Alignment Tool, P/N 2108570, place the aligning tool on the left edge of the disk array aligning shield so that the rubber pad is lined up with the top three disks already installed. Tighten the clamping screw finger-tight so that the pad holds the top disks from rotating. Install the next spacer and disk, rotating the disk so that the scribe mark on the disk is centered in the aligning gap on the aligning tool. Loosen the aligning tool clamping screw and move the tool up so the rubber pad again bears on the top three disks. Continue the installation and alignment of disks until all disks, including the top dummy disk, are accurately aligned.
5. If a number of the top disks and spacers stack up above the rotating shaft and the Allen screws for the clamping ring do not reach the rotating shaft, the following procedure is necessary. Check the appearance of the stack for unevenness. A spacer may be out of the slot or a disk may be cocked.
It may be necessary to insert an .008″ feeler gage between the rotating shaft and the disk spacers where the spacer springs are located. This prevents the spacer springs from catching on to the rotating shaft (at point "X" on Figure 3-13a) when the disks are clamped down.
a. Insert three long pull-down screws in equally spaced holes in top of rotating shaft.

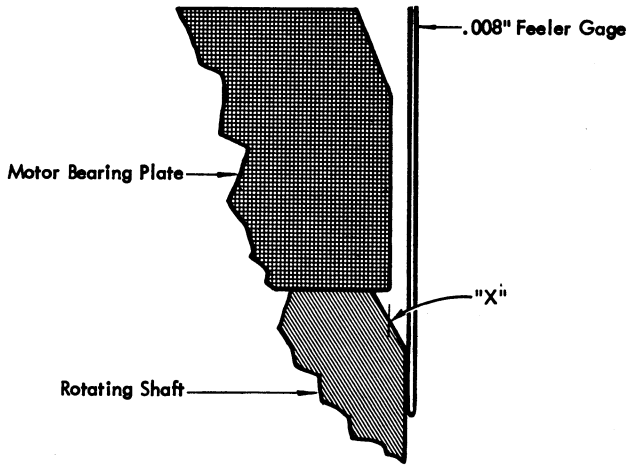


Figure 3-13a. Top Bearing Head Plate

b. Slip clamping ring over screws and place flat washers and nuts on screws.
c. Work spacers and disks carefully down into place by alternately tightening nuts on the pull-down screws. Guide spacer blocks and springs into place as they encounter rotating shaft.
d. In the event the spacers build up above the rotating shaft, it may be expedient to place the one or two top spacers in place without disks, and pull the lower part down first. Repeat with top disks in place.
e. Insert regular clamping screws in remaining holes. Remove pull-down screws and replace with regular clamping screws.

6. Tighten clamping screws evenly. Loosen them evenly, approximately three turns, to free any spacers which may bind.
7. With torque wrench (P/N 2108039) and socket adapter (P/N 2108040), retighten clamping screws evenly to 240 (+0, −50), inch-pounds of torque.
8. Replace top casting and spacer, and clamp down with bolt.
9. Install and fasten disk array shields.

CAUTION: Do not rotate disks by hand until after Step 10 has been performed. Record heads may be damaged by insufficient clearance.

10. Check head to magnet clearance at all heads. This must be done every time the top casting is removed and replaced. If the air gap is less than .005″ reposition record heads to allow at least .005″ clearance. Make proper head adjustments. (See RECORD START HEAD — ADJUSTMENT)
11. Replace dust cover and airfoil (dual access).
12. Install and fasten access mechanism.
13. Check arm-to-disk clearance at disk 00, disk 99, the new disk, and the disks above and below the new disk (see ACCESS MECHANISM AS AN ASSEMBLY).
14. Recheck record signal level and compare against previously recorded level.
15. Check record-start head adjustments.

Service Check

Clean the disks by using disk cleaning paddle (P/N 2108010) covered with a lint free cloth or absorbent paper. Insert paddle between two adjacent disks and turn the array by rotating the bottom disk. Repeat for all disks.

If dirt has adhered to the disk, the paddle covering may be dampened with isopropyl alcohol (70% or better by volume). No other cleaning agent is acceptable.

Record Start Head

Removal and Replacement

CAUTION: Remove disk storage power.

1. Remove top casting dust cover.
2. Carefully separate record head electrical connector.
3. Remove head mounting screws.
4. Remove record head.

To reassemble, position head for a maximum head-to-record magnet clearance. Tighten mounting screws snug tight, and reconnect head electrical connector. Adjust proper head to magnet clearance (see ADJUSTMENTS).

Adjustment

1. Adjust the head so that the output pulse from the record amplifier start hub is a minimum of +2.4 volts.
2. The sector heads on multiple access files are adjusted at the factory so that there is less than 40 μsec difference between accesses when using a scope synced on *record start* and observing the first indelible address AGC bit. It is essential that the heads be set to this tolerance on multiple access files for proper arm compatability.

CAUTION: Do not attempt to adjust spacing with disk array in motion. Do not decrease spacing below .005″.

Record Start Magnet

Removal and Replacement

CAUTION: Remove AC and DC disk storage power.

1. Remove top casting dust cover.
2. Remove top casting.
3. Remove the top disk *on 20 meg machines.* This step is unnecessary on 10 meg machines because the magnet mounting screws are accessible with the top disk in place.
4. Remove the magnet assembly mounting screws from the bottom of the top disk.

To replace the record start magnet, use the reverse procedure. Leave top casting dust cover off.

1. Check head to magnet clearance at all heads. This must be done every time the top casting is removed and replaced. Minimum air gap between record heads and magnet is .005″.
2. Check record head adjustments for all heads (see RECORD START HEAD — ADJUSTMENT Procedure).

Adjustment

1. There are no adjustments for the record start magnet; only the individual record start heads are adjustable for magnet-to-head clearance.

Disk Drive Motor

Removal and Replacement

In case of bearing failure or in situations requiring replacement of the disk storage drive, the complete shaft motor will have to be replaced. A special hoist is located in each parts distribution center. When the shaft motor is ordered, the parts distribution center will also send the hoist (Field B/M 2105754) along with a set of removal instructions.

Adjustment

None.

Service Check

Check run-down time every six months. All full-stack and single access half-stack machines should run down in over 10 minutes. Two and three access half-stack machines should run down in over eight minutes. Run-down times less than these just stated usually indicate that the shaft motor should be replaced. Until the motor is replaced, one ounce of Shell Cyprena grease (P/N 2127794) may be added to the upper and lower bearings. Bearing chambers are accessible through two grease plugs in both upper and lower bearing heads (180 degrees apart). The grease plugs are accessible through two holes in the top and bottom castings (Figure 3-13b). Grease should be added through one opening with the other plug removed.

Remote Air Compressor, General

The compressor cabinet contains a compressor driven by a three horsepower, 3ϕ, 208-v or 230-v AC motor operating at 1750 rpm. The compressed air flows from the aftercooler, through a filter water trap into two additional filters, through a shutoff valve and out through a swivel hose connector to the receiver tank (Figure 3-14). In addition, a pressure switch, solenoid, valve, and water pan in the cabinet provide an unloading system for the compressor.

Compressor

Service Check

Check oil level in the crankcase. Crankcase capacity is 32 ounces. Normal level is approximately at the bottom of the threads on the filler plug opening. Add oil, when necessary. Use Shell Hydraul #33 (IBM #2127714 pt can).

Drain and refill oil every 500 hours. Remove and clean the magnetic plug at this time. Keep compressor motor saddle clean. Excessive oil indicates an oil leakage at the crankcase cover plate or at aftercooler manifold. Tighten plate or manifold screws or replace gasket. Keep the aftercooler fins and external sides of cylinders clean.

Intake Filter

Service Check

WARNING: Never use solvents for cleaning filter elements.

Remove the pleated element and clean with brush or air nozzle. Replace element if badly clogged or broken. The frequency with which filters are cleaned and replaced depends on atmospheric conditions.

Dust Air Filters

Service Check

Remove dust by shaking or brushing. Replace, if badly clogged.

Drive Belts and Pulleys

Service Check

Check alignment and condition of belts. Belt deflection should be ¼" to ¾" with normal finger force. Realign the motor pulley, if necessary. Replace belts, if badly worn.

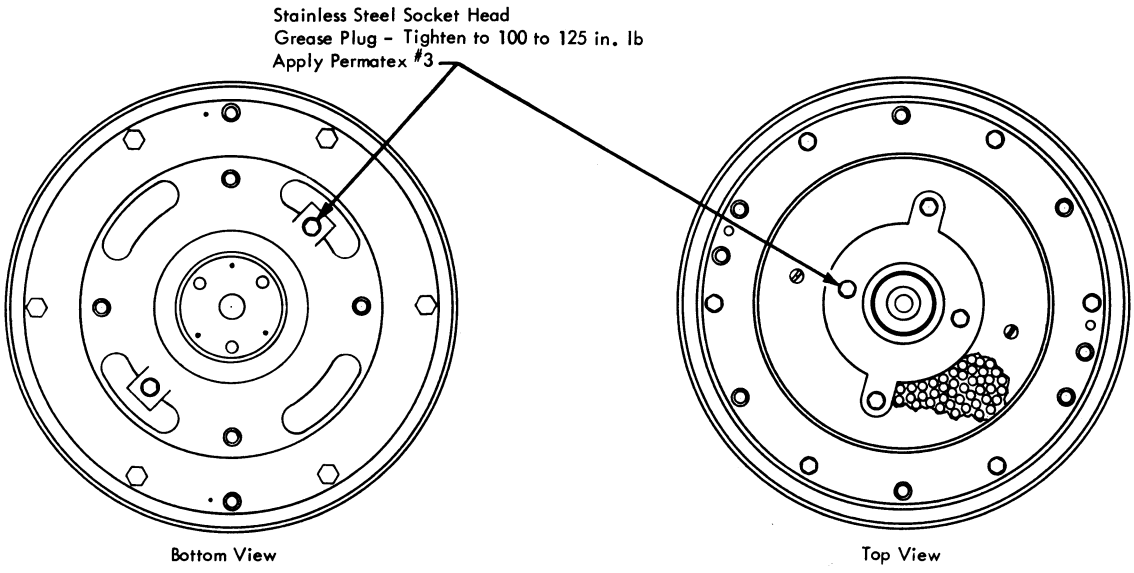
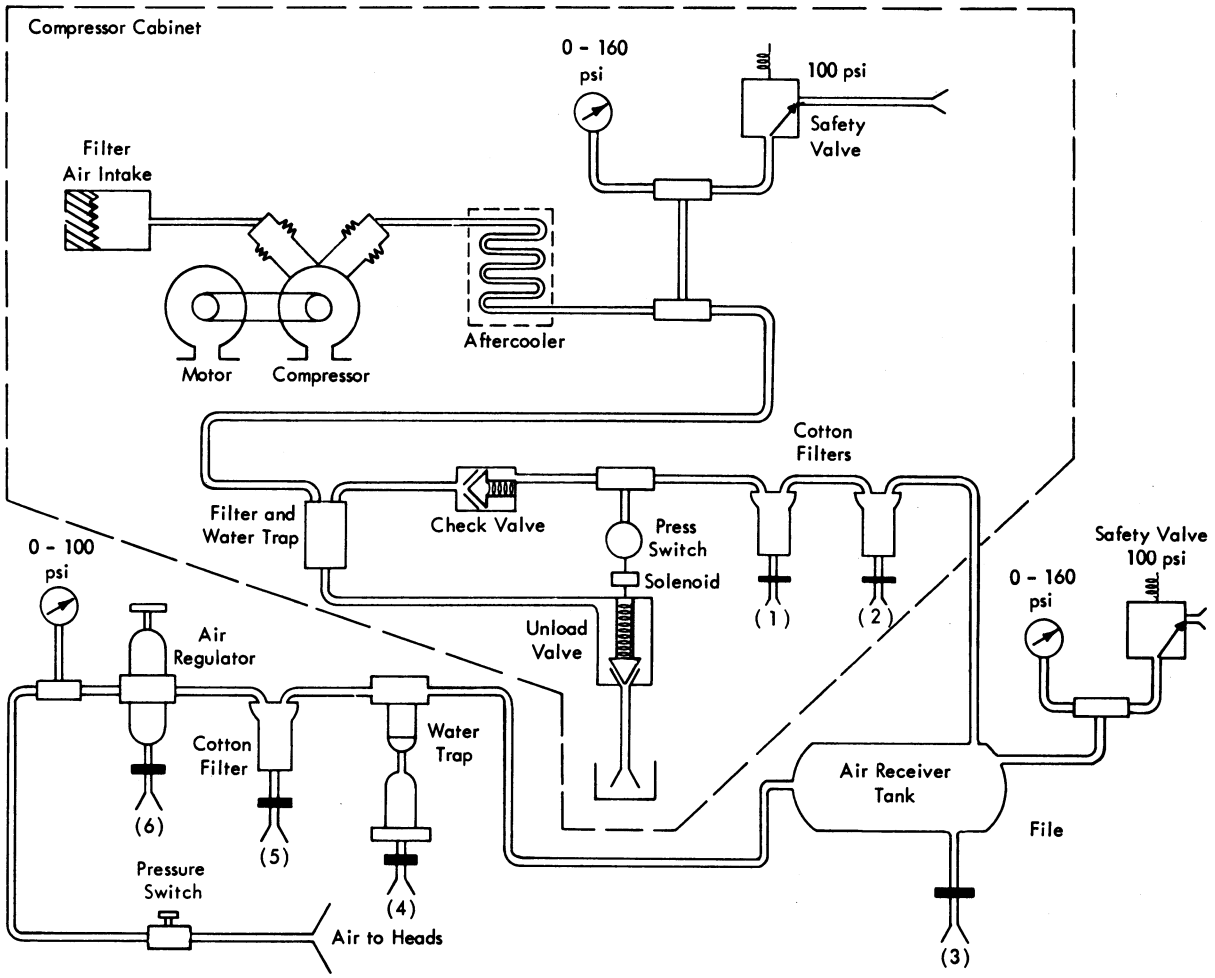


Figure 3-13b. Shaft Motor Lubrication Points



NOTE: There are 6 manually operated drain valves in this system. 1, 2, 3, and 5 are wing screw types. #6 is a knurled nut. #4 is an automatic drain. It can be manually operated (for checking) by lifting the valve with a straightened paper clip inserted up into the drain hole.

Figure 3-14. Air System Schematic

Check both pulleys for looseness on shaft and tighten, if necessary.

Filter-Water Trap

Service Check

Clean element and bowl with soap and water only. Replace element when necessary.

Pressure Switch

Service Check

Check pick and drop pressures (70 +4, −0 psig to 90 +4, −0 psig referenced to pressure gage in 1405), cut power to cabinet, and change differential with small double nut under leaf spring. Screw out to increase range. Raise and lower range with large center screw.

Cotton Filter Elements

Service Check

Check every six months. If very dirty, replace. A high carryover of oil will contaminate these elements more rapidly, and will require them to be checked and replaced more often.

Momentarily open sump valve to rid sumps of foreign material.

Safety Valve

Service Check

Pull release lever occasionally to unseat valve and prevent valve seat from sticking. This also flushes out foreign material. The safety valve is set to open at 100 psig + 6, — 0 psig.

Unloading Solenoid Valve

Service Check

Replace coil or diaphragm if unit becomes inoperative. Valve seat is in body and only requires cleaning. Clean valve by removing coil and upper plate.

Pressure Regulator

Set the pressure regulator at 55 +0, —2 psig with no air demand from heads or detents.

Pressure Gages

Service Check

Check gage next to safety valve frequently. Replace gage if needle does not zero or if gage reads excessively high or low compared to the other gages. When replacing the gage at the safety valve, remove damping plug and install new gage.

Blowers

Service Check

Clean intake screen and duct as required.

Air Receiver Tank

The air receiver tank contains a water trap assembly, a filter regulator assembly, zero to 160 pressure gage, zero to 100 pressure gage, a safety valve, and a receiver drain cock. An air pressure switch, located on the disk storage frame, signals the system when the air pressure is below 45 psi.

Receiver Tank

Service Check

Drain moisture from tank frequently. A drain cock for this purpose is provided on the underside of the tank.

Operate safety valve occasionally to prevent sticking.

Clean bottom bowl and element of regulator assembly. Use only water and dry the element thoroughly.

Pressure Switch

Service Check

The pressure switch contacts for the receiver tank (located on base of disk storage frame) should open when air pressure on the switch is 50 psi or more. Contacts should close when air pressure is between 43 and 45 psi. Adjust switch to obtain these conditions. The adjusting nut is located within the yoke holding the microswitch plastic housing. Turn clockwise to raise setting and counterclockwise to lower setting.

Compressor Tests

Leakage Test

Service Check

Test for possible leakage by performing the following steps:

1. Turn compressor on, build up pressure in receiver tank to 90 psig.
2. File can be on or off, heads loaded or unloaded.
3. Turn compressor switch to local position.
4. Turn off compressor at sequence control box start-stop switch.
5. Open compressor safety valve under sequence control box until all air in piping is exhausted. This releases air between the check valve and the compressor. Air should be retained from receiver tank to check valve.
6. Open receiver tank safety valve until pressure indicated by tank gage stabilizes at 90 psig. Pressure should then hold.
7. Note pressure drop in three minutes. Maximum allowable drop is 3 psi.
8. If the pressure drop is greater than 3 psi, check for line leakage using the soap bubble technique.

   If leakage is severe (8 to 10 psi) and line leakage is not evident or corrected, disconnect tube at input to unloading solenoid and look for air escaping from tube. This will indicate a defective check valve (reverse flow, Figure 3-14). The valve need not be replaced since leakage here will occur only at unloading time and is small because of unloading back pressure on the valve. If the valve is very bad, replace it.

Capacity Test

Service Check

Check the compressor capacity as indicated by the following steps:

1. Turn on compressor. The 1405 can be on or off and the heads unloaded.
2. Bleed air from receiver tank. Pressure will decrease to approximately 10 psi.
3. Discontinue bleeding tank and record time required for pressure to rise from 20 to 50 psi. Rise time for a full rated compressor at sea level is approximately 13 seconds. At 4,000 ft, rise time is approximately 14 seconds and at 7,000 ft it is about 15 seconds.
4. If the rise time is excessive (15 to 20 seconds) check for line leaks. If necessary replace intake filter element and/or high pressure cylinder intake and exhaust

valve assemblies. If after servicing, rise time has not decreased to 13 to 15 seconds, it may be necessary to replace the compressor.

Electronic Adjustments

Track Potentiometer Adjustment

The objective in making this adjustment is to position the track potentiometer gear with the track so the arm will servo to the correct track. This adjustment is accomplished by positioning the track potentiometer to minimize the track error voltage when the track is addressed to and detented at the track whose address deviates the most from the average.

▌CAUTION: Voltage is present on the clutch slip rings.

1. Connect CE Tester to file and turn Off Line switch to CE position.
2. Turn off access motor.
3. Move arm until the zero detent (nearest to disks) is opposite second tooth root, counting from head end of arm. This is track 00.
4. Address the disk storage to track 00 on the disk at which the arm is located.
5. Push Start key momentarily.
6. Connect oscilloscope between track error signal and ground.
7. Loosen adjusting screw lock-nut and adjust Allen screw (fine adjustment) until error voltage measured by scope is zero (±.1 volt). Adjust the screw by turning inward so that errors due to backlash can be eliminated. Tighten track potentiometer to bracket with hex nut. If the track potentiometer is being exchanged or if the fine adjustment stop is reached before error voltage reaches zero (±0.1v) perform the following steps.
   a. Disengage track potentiometer from arm by loosening bracket mounting screws.
   b. Turn adjusting screw (Allen head) completely in and back off two full turns. This sets the potentiometer for maximum fine adjustment in both directions.
   c. Rotate track potentiometer gear until the voltage is as near zero as possible and engage gear with arm rack. Lock potentiometer mounting bracket in place by tightening mounting screws so gear will not bind and will have a minimum amount of play (approximately .002").
   d. Adjust Allen screw for zero (±0.1v) as previously noted.
8. Record this voltage and reposition the track indicator if necessary.
9. Set up address 05 and move arm to this position by manually operating clutch. If the detent engages the wrong track, turn the No Null switch to TRACK. Move arm to correct position and record voltage.
10. Repeat Step 9 for tracks 15, 25, 35 to 195 (every 10 tracks).

    NOTE: If the track potentiometer is exchanged, Step 10 should be amended to read: "Repeat this procedure for all tracks."

11. Compare the voltages recorded for all tracks. The difference between the highest and lowest readings should not be greater than .75 volt. Algebraically add the highest and lowest reading. Address the arm to the highest wiper voltage track position and detent at this track. By turning the fine adjustment screw on the potentiometer assembly, reduce this reading to one-half the algebraic sum of the highest and lowest readings.

Home Potentiometer Adjustment

The objective in making this adjustment is to have the track potentiometer wiper (track error) signal equal to zero (±.1 volt) when the arm is in the home position (fully retracted).

▌CAUTION: Voltage is present on the clutch slip rings.

1. The track potentiometer adjustment must be correct before this adjustment is made.
2. Connect CE Tester to file and turn Off Line switch to CE position.
3. Turn off access motor.
4. Address the disk storage to 45000 and manually servo to that address.
5. Address the disk storage to a different disk.
6. Pull arm out until it stops. Disk detent should disengage and the home relay should pick.
7. Adjust home position potentiometer for a track error voltage to ground of zero (±.1 volt), measured with an oscilloscope.
8. Set up several disk addresses on Tester and manually rotate clutch to servo to these positions. Check for proper servo operation.

Disk Potentiometer Adjustment

The objective in making this adjustment is to minimize the disk wiper error voltage when the arm is addressed to and detented at the worst disk address. This adjustment is accomplished by positioning the disk potentiometer wiper.

▌CAUTION: Voltage is present on clutch slip rings.

1. Connect CE Tester to File and turn Off Line switch to CE position.
2. Turn off access motor.
3. Address the disk storage to disk 00.
4. Push Start key momentarily.
5. Move carriage to disk 00 by turning one of the clutches by hand.
6. Set Adjust switch to DISK NULL. This creates an artificial null. Air is then applied to clamp the carriage to the way.
7. Set Adjust switch to RUN.
8. Loosen two disk-wiper insulating-block holding screws and move wiper block up or down, as required, in parallel to potentiometer strip until error voltage at disk error signal, as measured by the scope, is 0 v (±.1 volt).
9. Address the disk storage to disk 05.
10. Move carriage to addressed disk by rotating clutch by hand. The disk detent should engage at this point. If it engages at the wrong disk, turn No Null switch to DISK and move the carriage to the correct disk. Turn NO NULL to RUN. Measure and record voltage at this address.

11. Repeat Steps 9 and 10 for every fifth disk, i.e., 5, 10, 15, 20, etc.

    NOTE: Steps 9 and 10 should be repeated for all disks if the disk potentiometer is replaced.

12. Address carriage to disk having highest wiper voltage. Position wiper to reduce this voltage to one-half algebraic sum of highest and lowest readings.
13. Set up several addresses in Tester and manually rotate clutch disk to servo carriage, and check for proper disk null operations.

Null Detector Adjustment

Track Null

NOTE: Before performing the track null adjustments, establish a disk null.

1. Turn the Adjust switch, for the access which is going to be adjusted, to the Track Null Positive position.
2. Monitor the Track Position Signal test point (located on the CE Panel) with oscilloscope.
3. Set the null adjust potentiometer to the zero position (0-volt output).
4. Monitor both the track output monitor points on the Servo Control Box of the particular null detector amplifier that is being adjusted. Adjust the balance and level potentiometers so that approximately −2 v to −4 v is present at both test points.
5. Using the null adjust potentiometer, set +0.4 volt at the track position signal test point which is input to the null detector. Adjust the level and possibly the balance of the amplifiers so the null relay picks. The picking or dropping of the null relays can be detected by observing the lights on the CE panel or listening for the sound of the relays and detents picking and dropping.
6. Turn the Adjust switch to the Track Null Minus position.
7. Repeat Step 5 for − 0.4 v. If the amplifier has been properly adjusted and balanced, there should be little or no variation between the positive and negative voltages.
8. By turning the null adjust potentiometer alternately in a clockwise and then counterclockwise direction, the null points can be checked very quickly to again verify the settings. The nulls should always be picked between +0.4 (+0.05) and −0.4 (−0.05) volts and dropped when outside the range of +0.5 (+0.3) to −0.5 (−0.3) volts.

Disk Null

1. Turn the Adjust switch to the disk null positive position.
2. Monitor the disk position signal test point with an oscilloscope.
3. Set the null adjust potentiometer to the ZERO position (0-volt output).
4. Monitor both the disk output monitor points on the servo control box (MP1 and MP2) of the particular null detector amplifier that is being adjusted. Adjust the balance and level potentiometers so that approximately −2 v to −4 v is present at both output pins.
5. Using the null adjust potentiometer, set +0.4 volt at the disk position signal test point which is the input to the null detector. Adjust the level and possibly the balance of amplifiers so the null relay picks.
6. Turn the Adjust switch to the Disk Null Minus position.
7. Repeat Step 5 for −0.4 volts. If the amplifier has been properly adjusted and balanced, there should be practically no variation between the positive and negative voltages.
8. By turning the null adjust potentiometer alternately in a clockwise and then counterclockwise direction the null points can be checked very quickly to again verify the settings. The nulls should always be picked between +0.4 (+0.05) volts and −0.4 (−0.05) volts.
9. Turn the Adjust switch to the RUN position.

Servo Clutch Amplifier and Motion Controls

NOTE: It is desirable to make these adjustments after the machine has been in operation for least two hours.

The disk and track nulls, and the disk, track, and home potentiometers must be in adjustment before the following steps are performed.

1. Turn access motors off.
2. Turn Adjust switch to clutch amplifier track position and then turn Access Inop switch to the access inop position .
3. The following two adjustments need to be done only on the initial setup of the servo. They are not necessary when checking adjustments, etc.
   a) Set both track and disk damping potentiometers on CE panel to approximately 75% of maximum.
   b) Set both tracks and disk servo time balance potentiometers on CE panel to approximately 50% maximum.
4. Monitor the outputs of the clutch amplifier at the test points on the servo heater box (MP5 and MP6) for the access being adjusted, and adjust the clutch amplifier level and track balance potentiometers so that approximately −1 v is present at both output test points.
5. Place oscilloscope or voltmeter at each of the two clutch driver emitters.
   For Access 0-pins at 1A05-H and 1A07-H.
   For Access 1-pins at 1A25-H and 1A27-H
   For Access 2-pins at 1A15-H and 1A17-H.

   NOTE: Reference measuring instrument to pin indicated: for Access 0-pin B13Q; for Access 1-pin B21Q; for Access 2-pin B17Q.

6. Turn the No Null switch to the track position.

WARNING: Switch is to be left in this position only as long as is necessary to complete Step 7.

7. Adjust the clutch amplifier level and track balance potentiometers so that the voltage at each of the two "H" pins is between −0.4 and −0.65 volts. This condition represents a balanced clutch null for track with a crossover current between approximately 55 and 85 milliamperes.
8. Turn the Adjust switch to the clutch amplifier disk position.
9. Turn the No Null switch to disk position.

WARNING: Switch is to be left in this position only as long as is necessary to complete Step 10.

10. Adjust the clutch amplifier disk balance potentiometer so that the voltage at the two "H" pins is between −0.4 and −1.00 volts. This represents a balanced clutch null for disk.
11. Turn the No Null switch, Access Inop switch and the Adjust switch to the RUN position.
12. Remove all instruments.
13. Turn on access motor.
14. Initiate a seek loop between 0000 and 0199.
15. Adjust the track damping potentiometer until an access time of 360 ms (min) to 390 ms (max) is noted between "servo start" and "ready" for a 0000 to 0199 and back to 0000 servo (see Step 16).
16. The previous adjustment can affect clutch amplifier balance. Use the following procedure to dynamically check and, if necessary, refine the clutch adjustment for track servos.
    a) Servo to an address. Verify that the track position signal is zero volts.
    b) Turn No Null switch alternately from the Run position to the Track position and observe arm for in or out motion as the track detent retracts. If the track clutch balance potentiometer is properly adjusted, no in or out motion of the arm should occur. If motion does occur, perform Step c.
    c) While turning the No Null switch alternately from the Run position to the Track position, adjust the track clutch balance potentiometer until in or out arm motion is at a minimum.
17. As a check on overshoot, the track position signal should be monitored for a seek loop between 0000 and 0199.
    a) If overshoot occurs in one direction and not the other, then the track servo time balance potentiometer should be adjusted to eliminate this condition.
    b) If overshoot occurs in both directions, the track damping potentiometer should be adjusted to maintain the servo within overshoot specifications of 0.5 volts.

    NOTE: If an adjustment has been made here, check Step 15 to ensure that the track servo time is within the stated limits.

18. Reset seek instruction to stop servo.
19. Initiate a seek loop between 0199 and 9999.
20. Adjust the disk damping potentiometer until an access time of 750 ms (min) to 800 ms (max) is observed between "servo start" and "ready" for the 0199 to 9999 and 9999 to 0199 servos, respectively (see Step 21) ~~for 20 meg~~ file.

    Access time for 10 meg file is 625 ms (min) to 700 ms (max) and addresses used are 0199 to 4999.
21. The previous adjustment can affect clutch amplifier balance. Use the following procedure to dynamically check and, if necessary, refine the clutch adjustment for disk servos. Verify that the disk position signal is zero volts.
    a) Turn No Null switch alternately from the Run position and observe carriage for up or down motion as the disk detent retracts. If the disk clutch balance potentiometer is properly adjusted, no up or down carriage motion should occur. If motion does occur, perform Step b.
    b) While turning the No Null switch alternately from the Run position to the Disk position, adjust the disk clutch balance potentiometer until up or down carriage motion is at a minimum.
22. As a check on overshoot, the disk position signal should be monitored for a seek loop between 0199 and 9999.
    a) If overshoot occurs in one direction and not the other, then the disk servo time balance potentiometer should be adjusted to eliminate this condition.
    b) If overshoot occurs in both directions, the disk damping potentiometer should be adjusted to maintain the servo within overshoot specifications of 0.5 volts.

    NOTE: If an adjustment has been made here, check Step 20 to ensure that the servo time is within the stated limits.

23. Disconnect all instruments.

File Clock Oscillators

This adjustment sets the frequency of the write oscillator for the correct gap between records. The second oscillator is set to the same frequency.

WARNING: The oscillators are initially adjusted at the factory and should need no further adjustment. Any frequency change made after the machine has been used by the customer might affect reading the data previously recorded.

Adjustment

1. Turn CE test lock on.
2. Program machine to loop full-track write and full-track write check operations in the move mode.
3. Set scope for 100 μsecs/div and sync on *end record gate* and *record 5*.
4. Scope count one trigger at 01A2G22N. The elapsed time from *end record gate* to the first *count one* pulse must be 720 ±100 μsec for single file systems. For multiple file systems the elapsed time for one file must be 720 ±100 μsecs and for the remaining files it must be 720 (+150 − 100) μsecs.
5. Adjust the coil of the write oscillator at 01A2C09 until the elapsed time in Step 4 is obtained. Record this time.
6. Exchange the read and write oscillator cards with one another. Adjust the read oscillator, now in the write oscillator position, using the previous steps, until the gap time is the same as was recorded in Step 5.

Read Amplifier Adjustment (E/C 405167 not installed)

The block diagram in Figure 3-15 illustrates the read amplifier without E/C 405167 installed.

AGC System Adjustment

1 Detent the access arm at track 200.
2. If dual input oscilloscope with differential amplifier

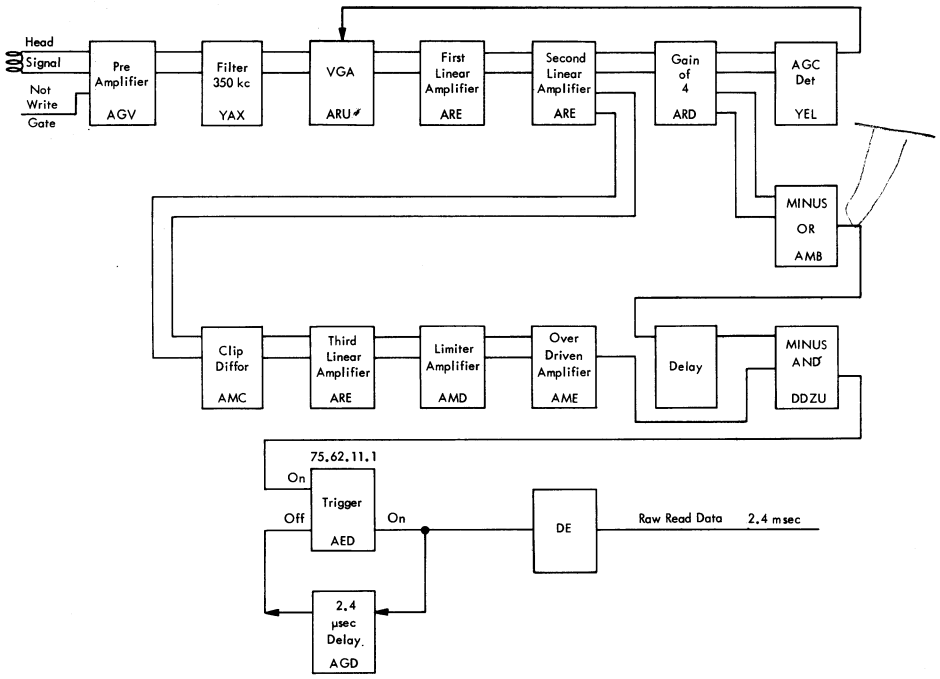


Figure 3-15. Read Amplifier Block Diagram

is used, observe the output of B1K08B and K08D (or K08C and K08H). The record AGC bits should be 10 or 15 volts peak-to-peak, for the first few pulses, then fall in a symmetrical pattern so that the first character of the record is under a maximum of 8 volts peak-to-peak and the following characters fall to no less than a 5.5 volt peak-to-peak minimum. Refer to Figure 3-17 and adjust the potentiometer at B1K11 to obtain these specifications.

3. If a single input oscilloscope is used, observe the output of B1K08B or K08D. The record AGC bits should be 5 to 7.5 volts peak-to-peak for the first few pulses. then fall in a symmetrical pattern so that the first character of the record is under a maximum of 4 volts peak-to-peak and the following characters do not fall below a 2.75 volt peak-to-peak minimum. Refer to Figure 3-17 and adjust the potentiometer at B1K11 to obtain these specifications.
4. Typical peak-to-peak signal levels of the various units are shown in Figure 3-16a through 3-16c.

OR Circuit Clipping Level

The clipping level of the OR circuit (1K12) is set to clip 40% of the nominal output signal of the clipper amplifier. The adjustment is as follows:

1. Set up scope for 2 ms/div and 1v/div.
2. Sync on *record start.*
3. Probe monitor point at 1K12C or D to observe read data.
4. Adjust the vertical position of the trace so that the record gap base line is set on a horizontal graticule.
5. Adjust the vertical amplitude of the unclipped portion of the trace, using the voltage calibration knob, so that the base to peak signal of the trace is four divisions in amplitude (25% per division).
6. Adjust the 2K potentiometer on the OR circuit until a clipping level of 40% is obtained as shown in Figure 3-18.

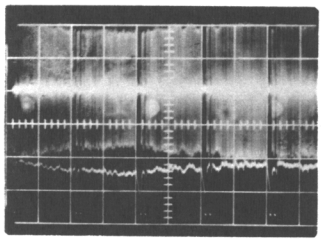
Minus AND Circuit Adjustment

The objective is to obtain baseline voltage levels at both input pins of the Minus AND Circuit by adjusting the amplifier input on Pin D to match the delay input on Pin C.

1. Monitor K17C, using 1 volt per centimeter scale, and note the DC baseline level of the data.
2. Monitor K17D and adjust the potentiometers on K15 and K16 until the baseline is at approximately the same DC level as observed at K17C. This will be near the counterclockwise end of adjustment range of both potentiometers. Do not leave the potentiometers on the end of their range, turn counterclockwise until data disappears (indicating that the 1405 is not reading correctly), then clockwise at least one full turn after data reappears on scope. See Figure 3-19.

Trigger Output

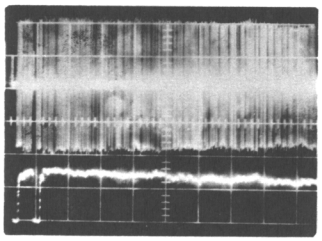
1. If the preceding amplifier adjustments have been made, check the trigger circuit output at B1K20P to see that each bit is a minimum of 2 μsecs wide. If not, the trigger or associated delay circuit may be defective.



Fulltrack Head Signal

Top:
1K04 A-B
5 ms/Div
20 mv/Div

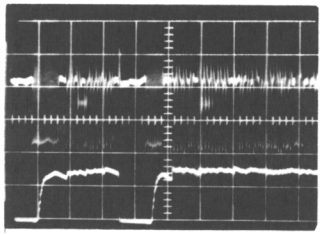
Bottom:
AGC
1K06 A
5 ms/Div
1 volt/Div



Single Record Head Signal

Top:
1K04 A-B
1 ms/Div
20 mv/Div

Bottom:
AGC
1K06 A
1 ms/Div
1 volt/Div

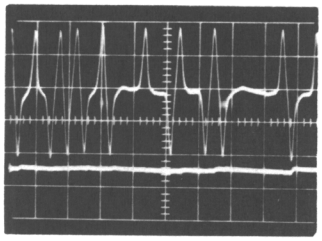


Top:
AGC, Indelible Address
and Start of Record
200µsec/Div
20 mv/Div
1K04 A-B

Bottom:
AGC
1 volt/Div
200µsec/Div

Top:
Output of Preampl
1K04 A-B
20µsec/Div
20 mv/Div

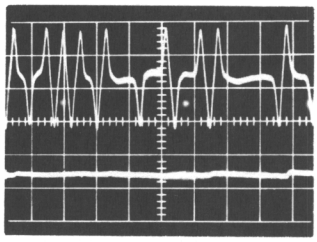
Bottom:
AGC
20µsec/Div
500 mv/Div



Top:
Output of Filter
1K05 A-B
20µsec/Div
20 mv/Div

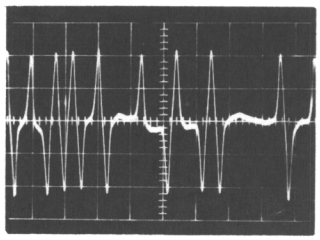
Bottom:
AGC
20µsec/Div
500 mv/Div

Figure 3-16a. Read Amplifier Waveforms (As displayed on a 555 scope, E/C 405167 not installed)

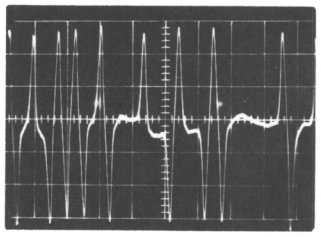


Top:
Output of AGC
1K06 B-E
20µsec/Div
20 mv/Div

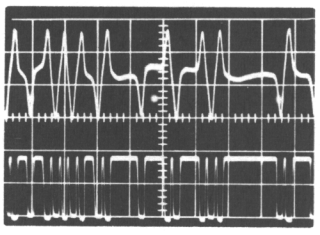
Bottom:
AGC
20µsec/Div
500 mv/Div



Output of First Linear
Ampl 1K07 C-H
V-Gain 15
20µsec/Div
100 mv/Div

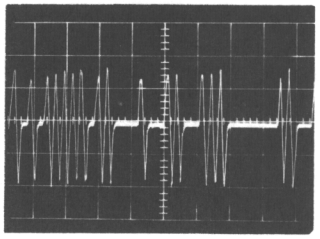


Output of Second Linear
Ampl 1K08 B-D
V-Gain 15
20 µsec/Div
1 volt/Div



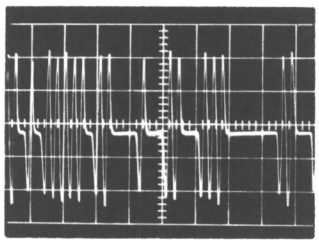
Top:
Output of Gain of Four
Ampl 1K10 C-D
20µsec/Div
10 volts/Div

Bottom:
Output of MINUS OR
1K12G
20µsec/Div
1 volt/Div

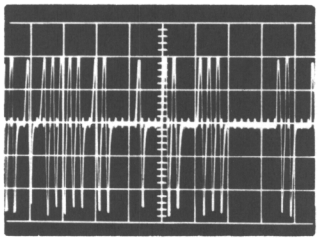


Output of Clipper
Differentiate 1K13 F-H
20µsec/Div
100 mv/Div

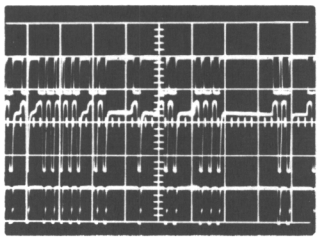
Figure 3-16b. Read Amplifier Waveforms (As displayed on a 555 scope, E/C 405167 not installed)



Output of Differentiated
Signal Linear Ampl
1K14 C-H
20μsec/Div
100 mv/Div



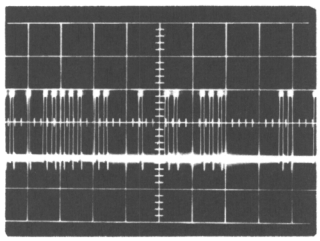
Clipped and Differentiated
Signal
1K15 A-B
20μsec/Div
V as Needed (5 v)



Inputs and Output of
MINUS AND at 20μsec/Div
1K17 C 2 volts/Div

1K17 D 2 volts/Div

1K17 B 5 volts/Div



Standardized Read Data
1K20 P
20μsec/Div
5 volts/Div

Figure 3-16c. Read Amplifier Waveforms (As displayed on a 555 scope, E/C 405167 not installed)

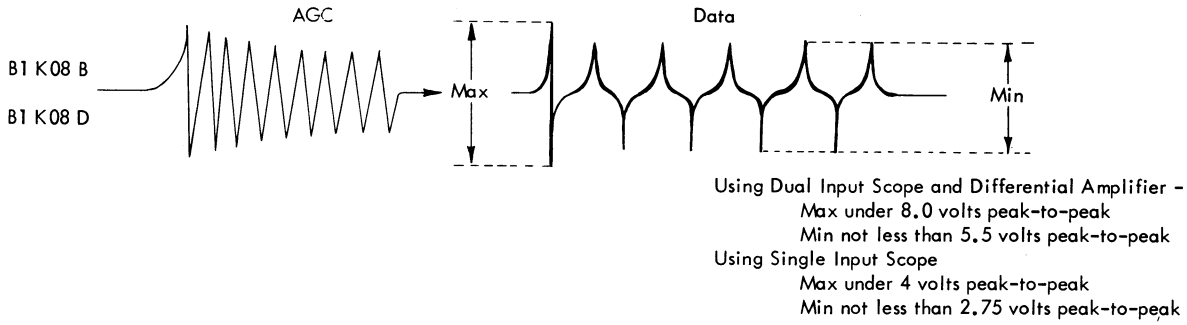


Figure 3-17. AGC System Adjustment

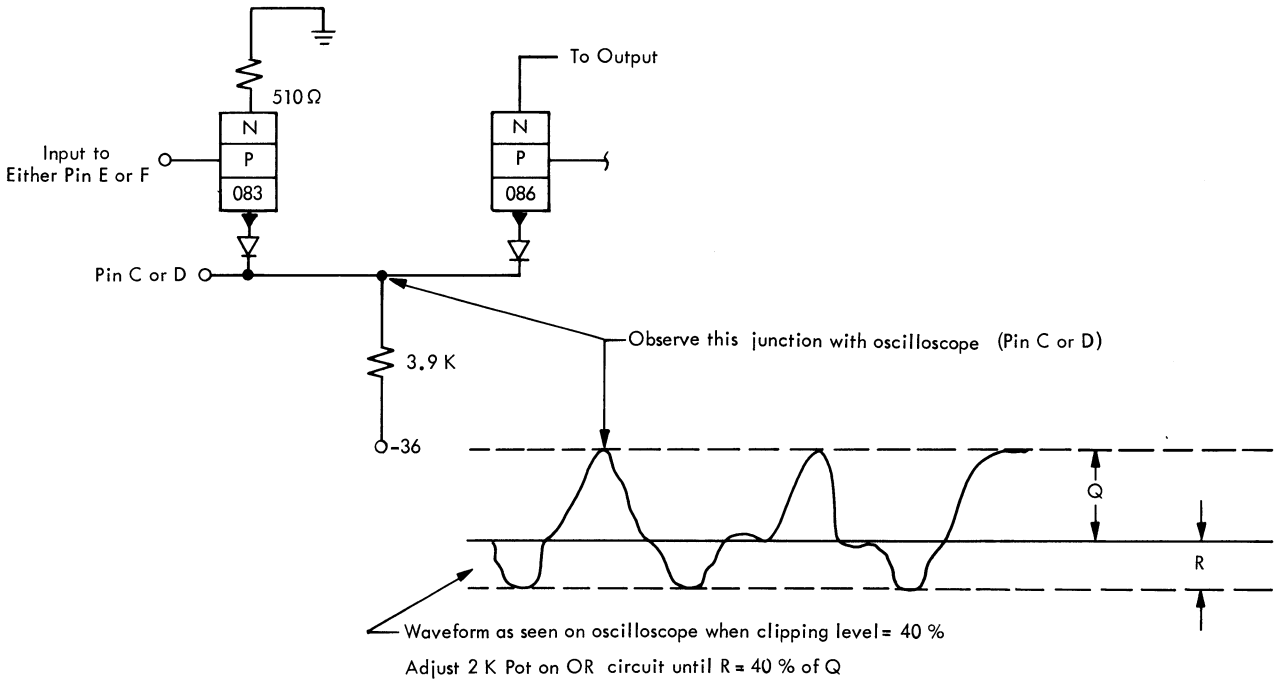


Figure 3-18. OR Circuit Clipping Level

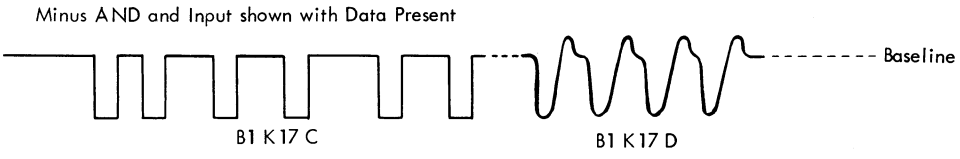


Figure 3-19. Minus and Circuit Adjustment

Read Amplifier Adjustment (E/C 405167 installed)

The block diagram in Figure 3-20 illustrates the read amplifier with E/C 405167 installed. Figure 3-16a and oscillograms of 1K06 and 1K07 in Figure 3-16b are applicable to this read amplifier.

AGC Adjustment

1. Detent access arm at track 100 and perform a read operation.
2. Set up scope (single input) to observe the output from 1K08B or 1K08D.
3. Adjust the 1K potentiometer at 1K11 until the observed average amplitude of the first record address character is 3 volts peak-to-peak (Figure 3-21).

OR Circuit Adjustment

The objective of this adjustment is to prevent the OR circuit stage of the OR-AND circuit from being activated by any input voltage less than 30% or greater than 50% of the undistorted negative portion (base-to-peak) of the input waveform.

1. Servo to an inside CE track and write blanks on a record.
2. Set up the scope as follows:
   a) Use AC input at 2 ms/div and 1 v/div.
   b) Probe the input at 1K12F to observe blanks written in Step 1.
   c) Adjust the voltage calibration knob so that the amplitude of the observed negative spike (base-to-peak) just covers 5 scope divisions. Record the base line (Figure 3-22).
   d) Probe the monitor point at 1K12A and line up the observed base line with the base line recorded in Step C.
3. Adjust the 2K potentiometer on 1K12 to clip the signal to 40% of the total amplitude of the negative pulses observed in Step d (40% = two major scope divisions, Figure 3-23).
4. Check monitor point 1K12A while reading from each head. Clipping should be between 30% and 50%.
5. Check 1K20P for a nominal output pulse width of 1.7 μsecs (Figure 3-24). Maximum pulse width is 2.5 μsecs, minimum pulse width is 1.5 μsecs. Rise time should be 0.5 μsecs at 90% of signal.

Minus AND Circuit Adjustment

The objective of this adjustment is to obtain similar base line voltage levels at the inputs to the minus AND stage of OR-AND circuit. The objective is accomplished by adjusting the amplifier input to 1K12G so as to match the delay input at 1K12H.

1. Use the same record used during Step 1 of the AGC adjustment.
2. Set scope on DC input, 1 v/div, 0.1 ms/div, X5 and observe 1K12H. Record the DC base line level of the data observed (Figure 3-25).
3. Observe 1K12G and adjust the potentiometers on 1K15 and 1K16 until the base line is at approximately the same DC level as observed at 1K12H (Figure 3-26). Both potentiometers will be near the counterclockwise end of their adjustment range. Do not leave the potentiometers near the end of their range; turn counterclockwise until data disappears (indicates that the 1405 is not reading correctly), then turn clockwise at least one full turn after data reappears on scope.

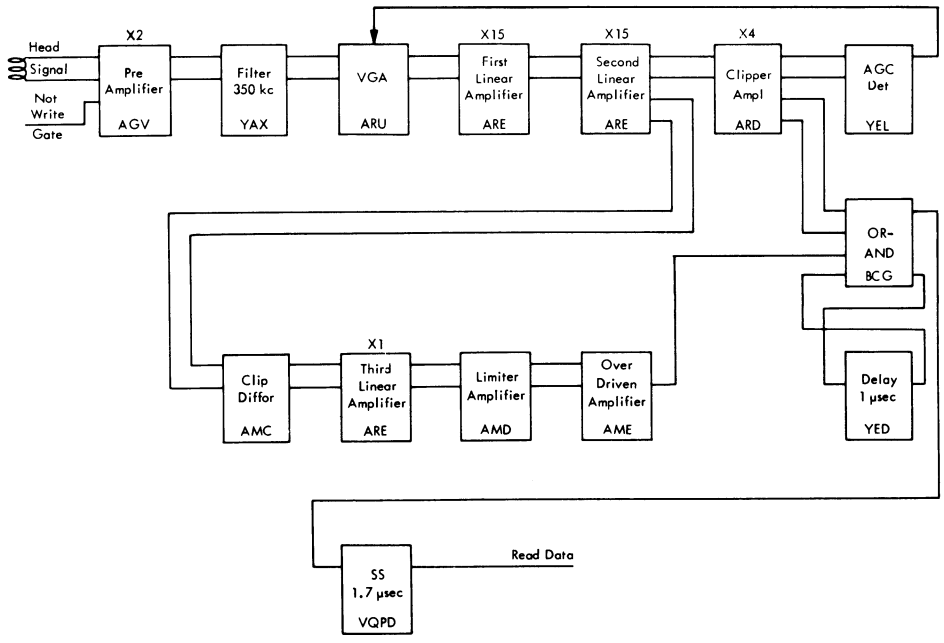


Figure 3-20. Read Amplifier Block Diagram

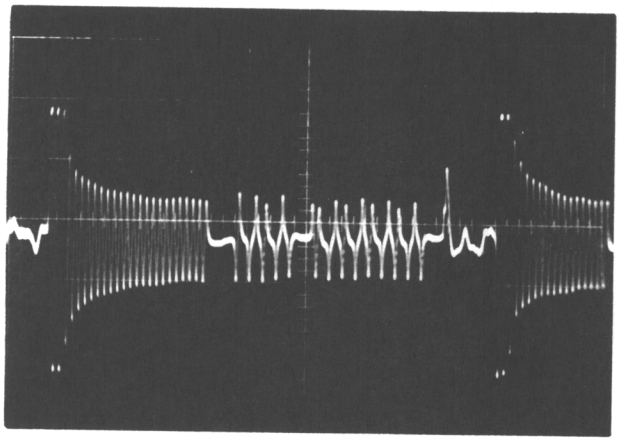


Figure 3-21. 1K08B (0.1 ms/div, 2 v/div)

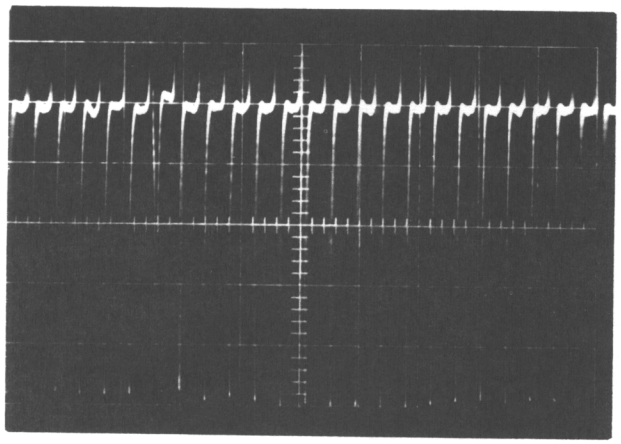


Figure 3-22. 1K12F (2 ms/div, 1 v/div – adjusted)

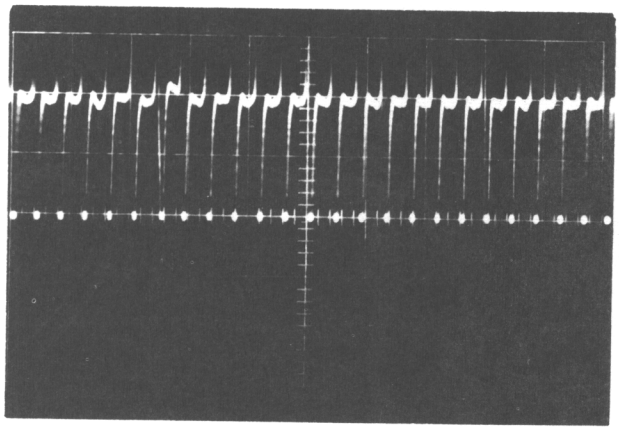


Figure 3-23. 1K12A (2 ms/div)

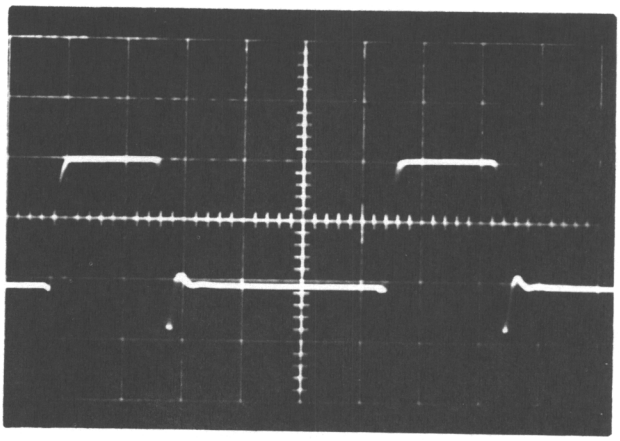


Figure 3-24. 1K20P (5 μsec/div, 5 v/div, X5)

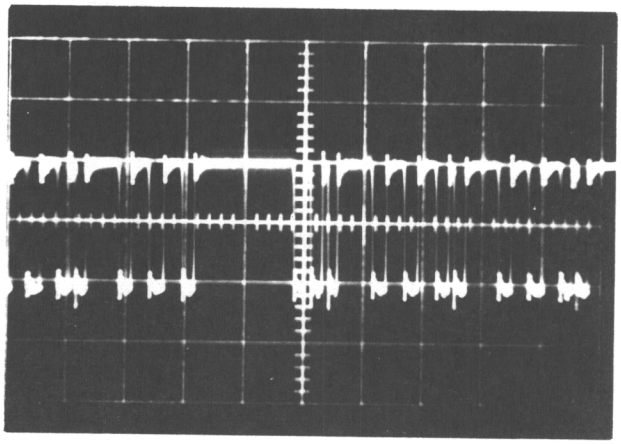


Figure 3-25. 1K12H (0.1 ms/div, 1 v/div, X5)

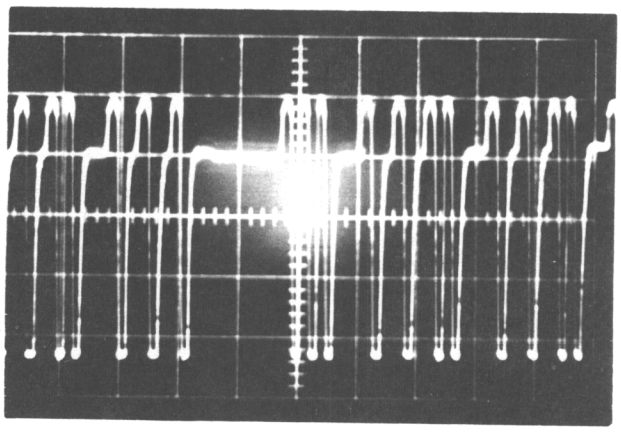


Figure 3-26. 1K12G (0.1 ms/div, 1 v/div, X5)

Section 4 Machine Locations

Contents

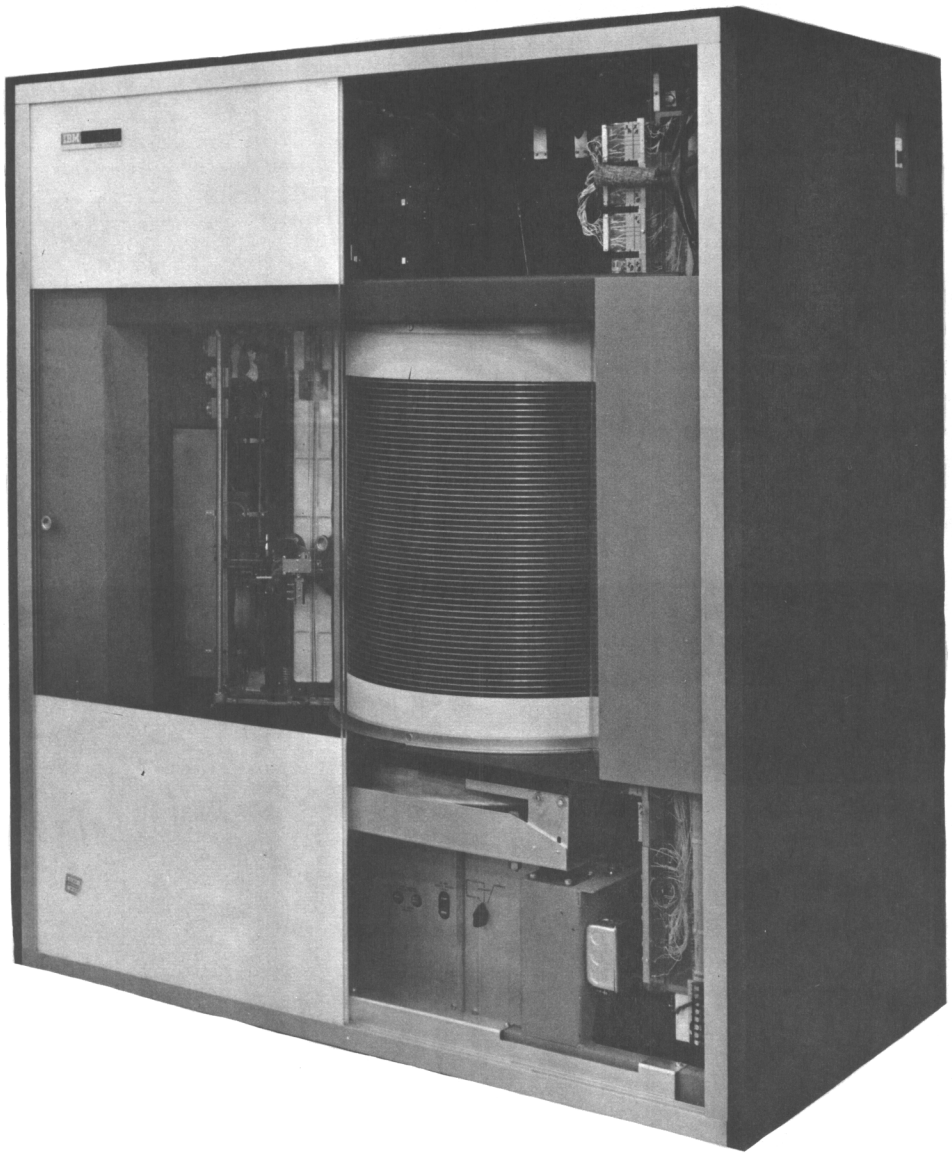


Figure 4-1. 1405 Disk Storage (Front)

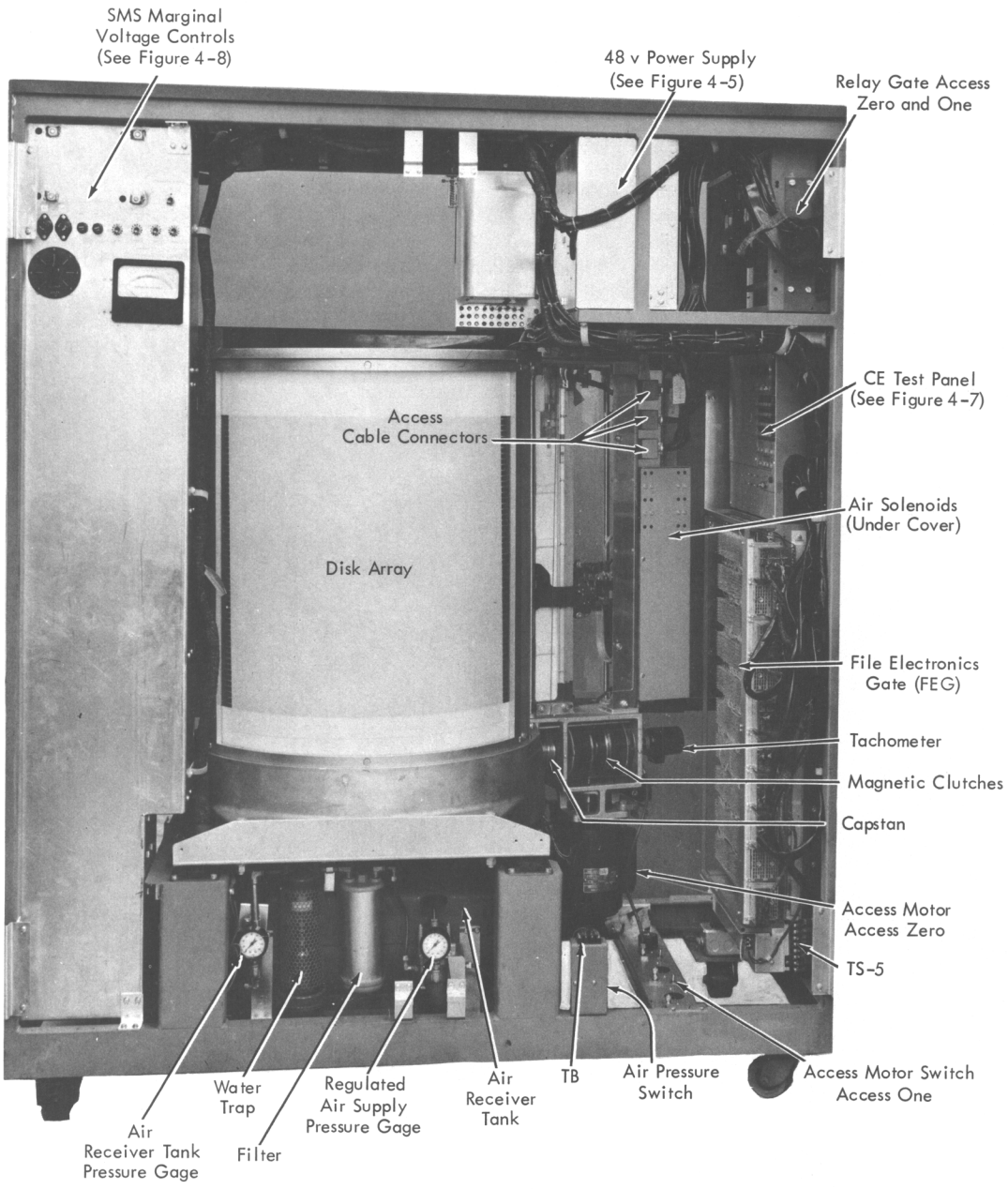


Figure 4-2. 1405 Disk Storage (Rear)

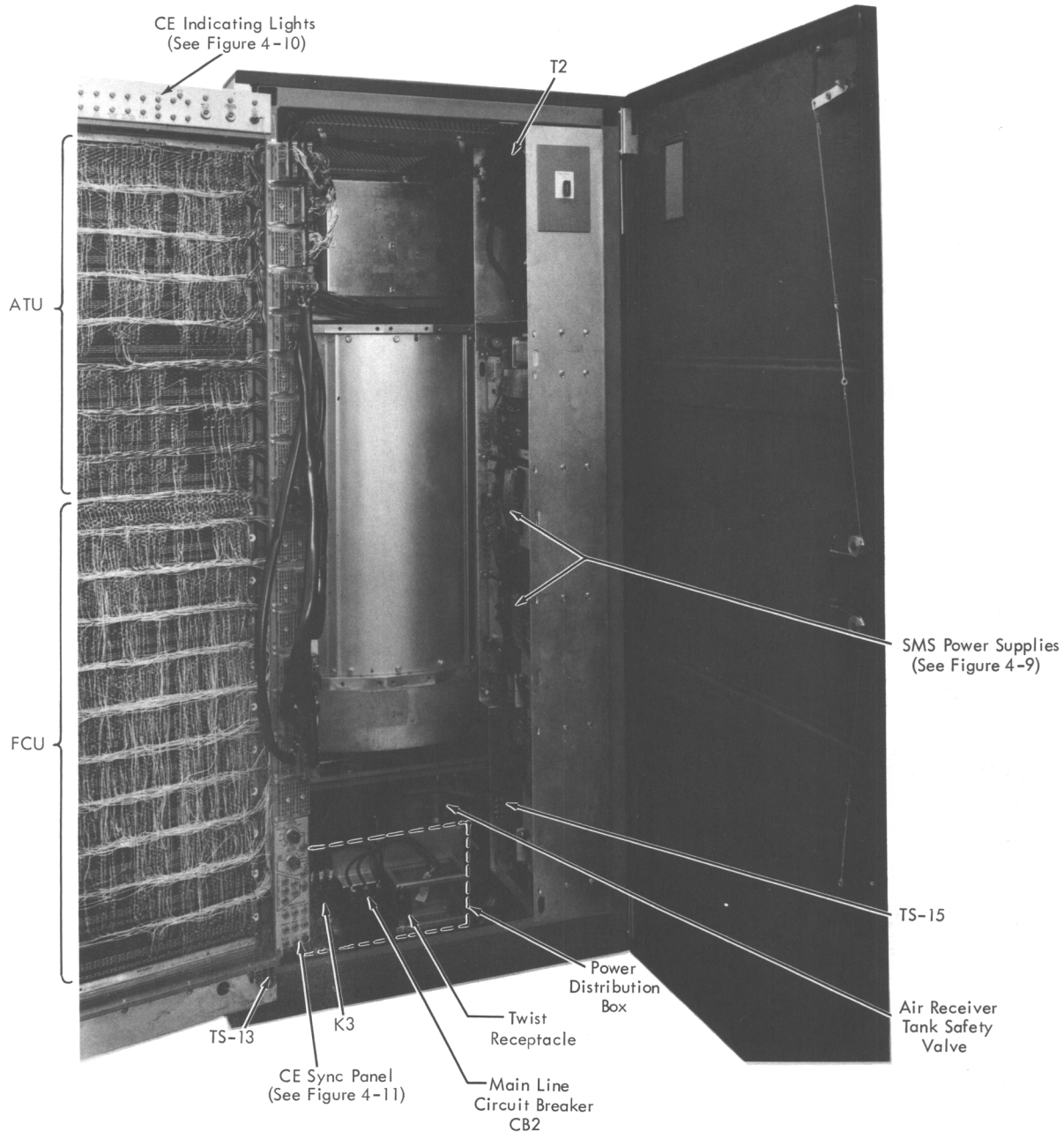


Figure 4-3. 1405 Disk Storage (Right-End)

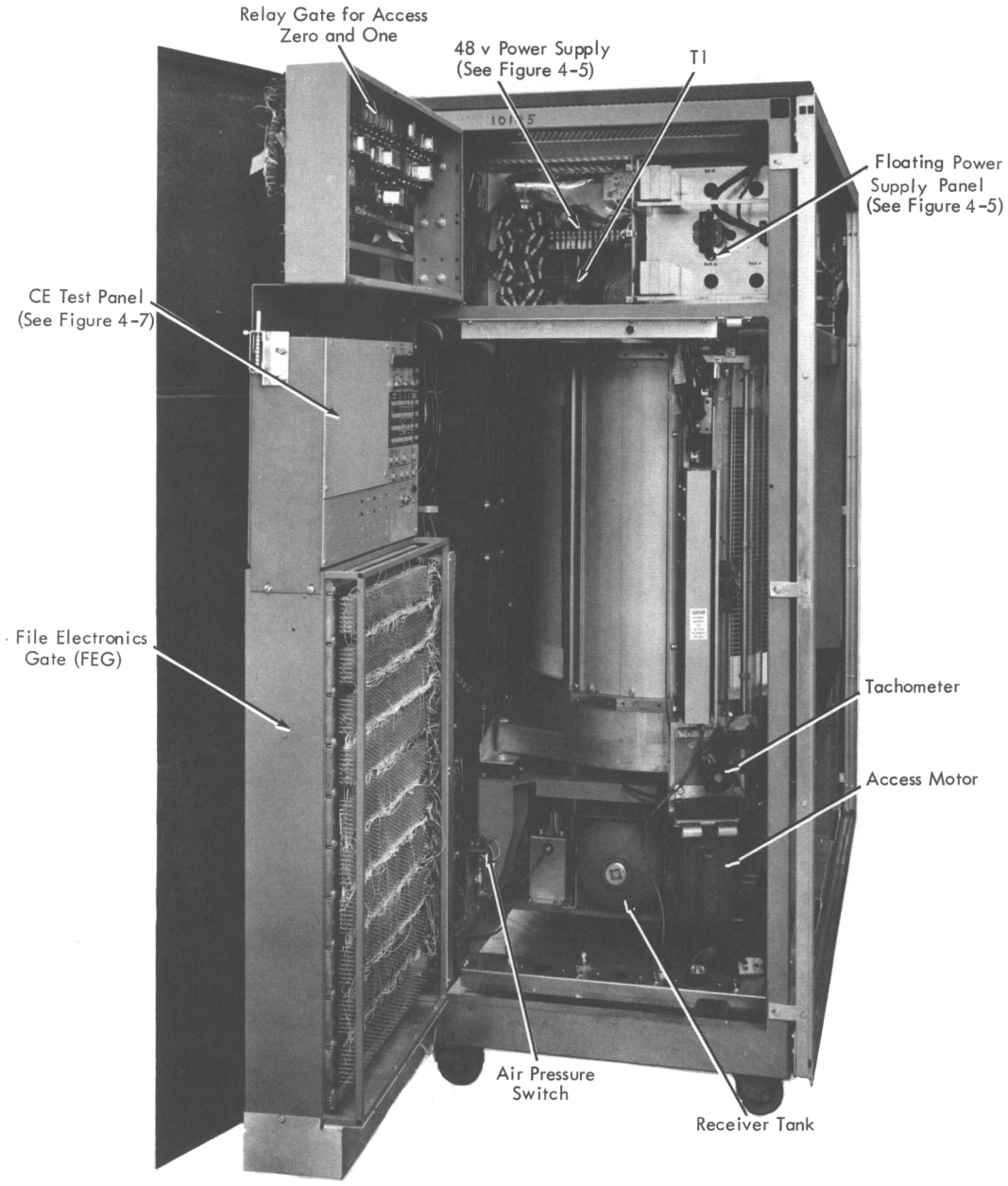


Figure 4-4. 1405 Disk Storage (Left-End)

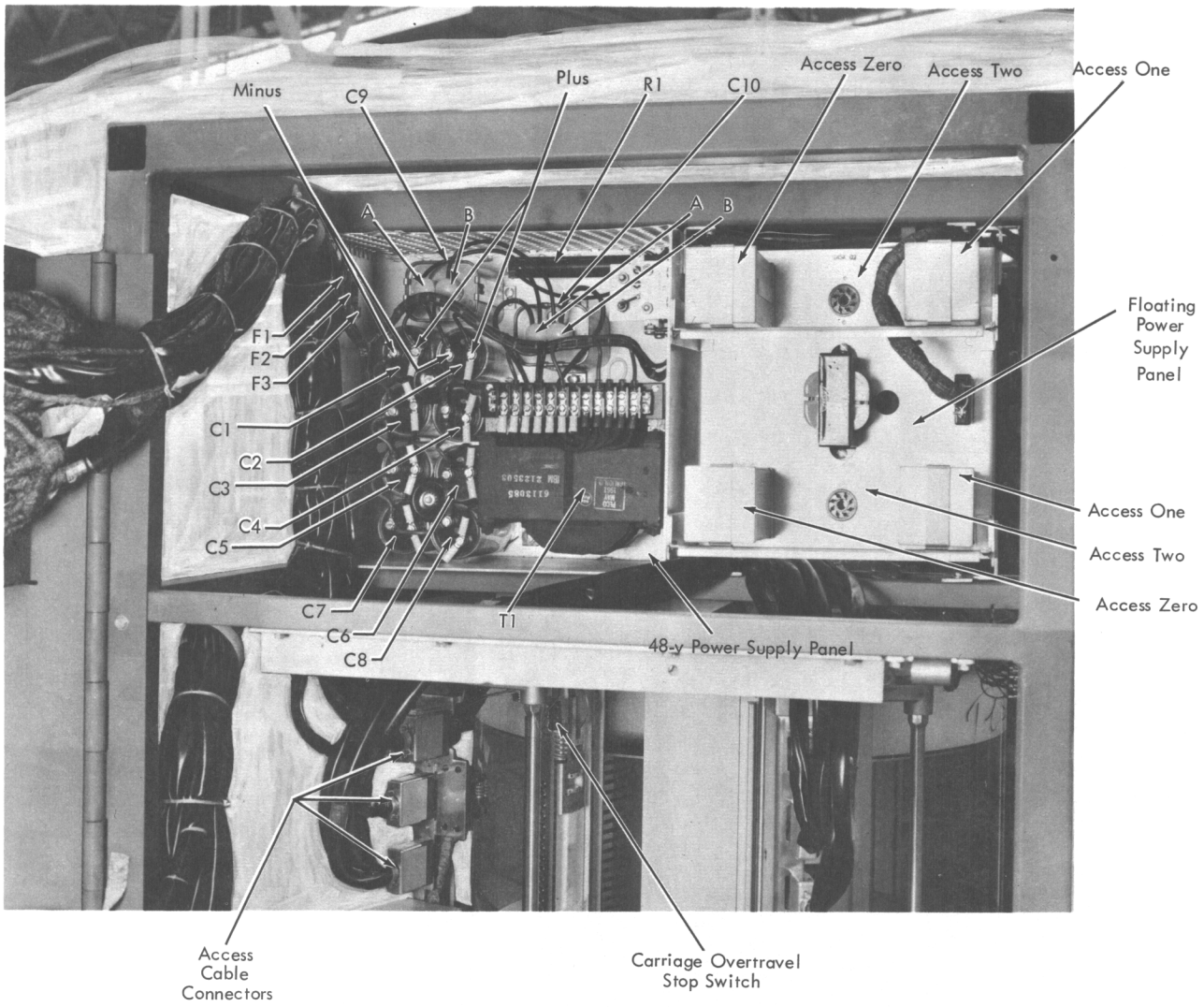


Figure 4-5. 48-volt and Floating Power Supplies

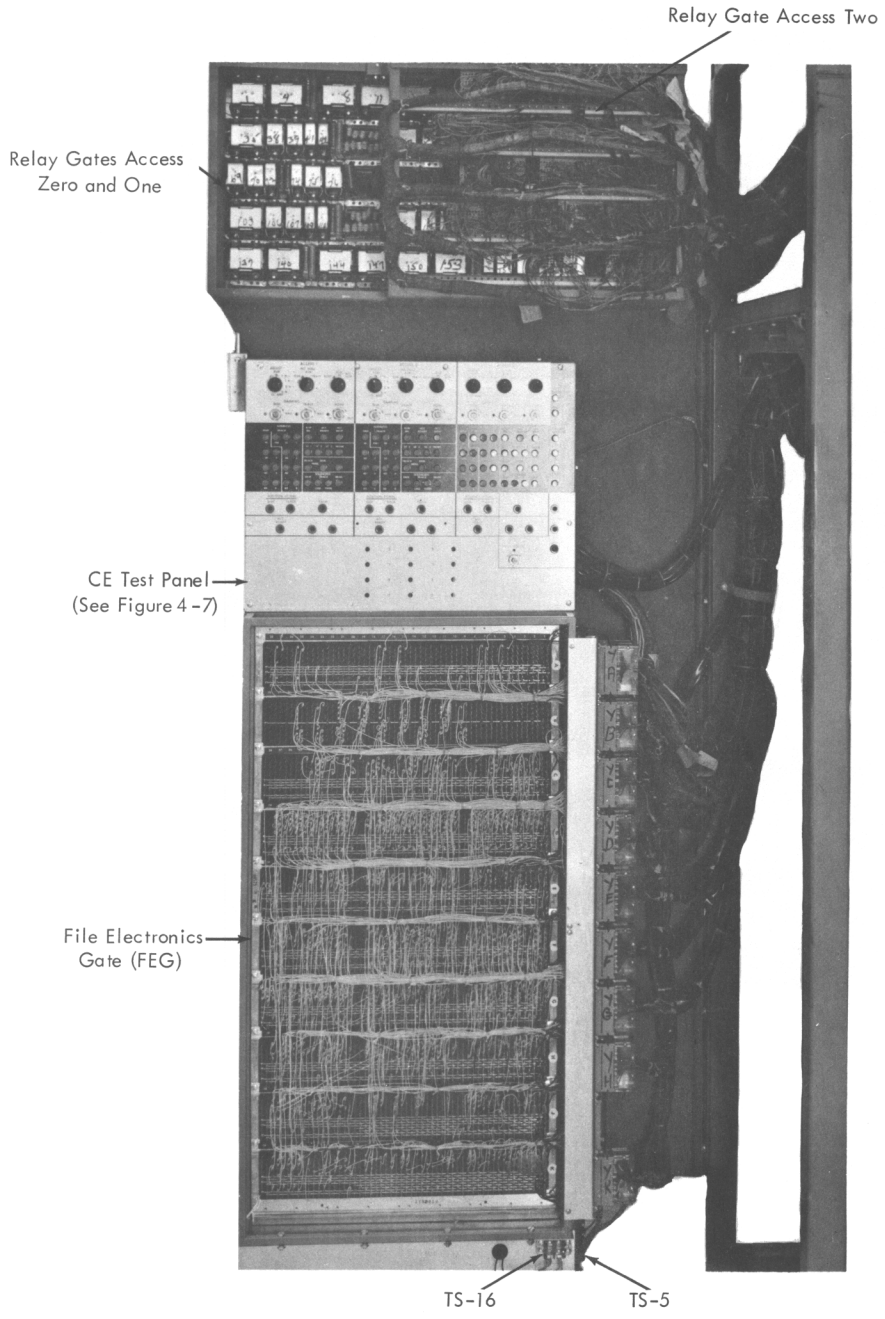


Figure 4-6. 1405 Disk Storage (Left-End Gates)

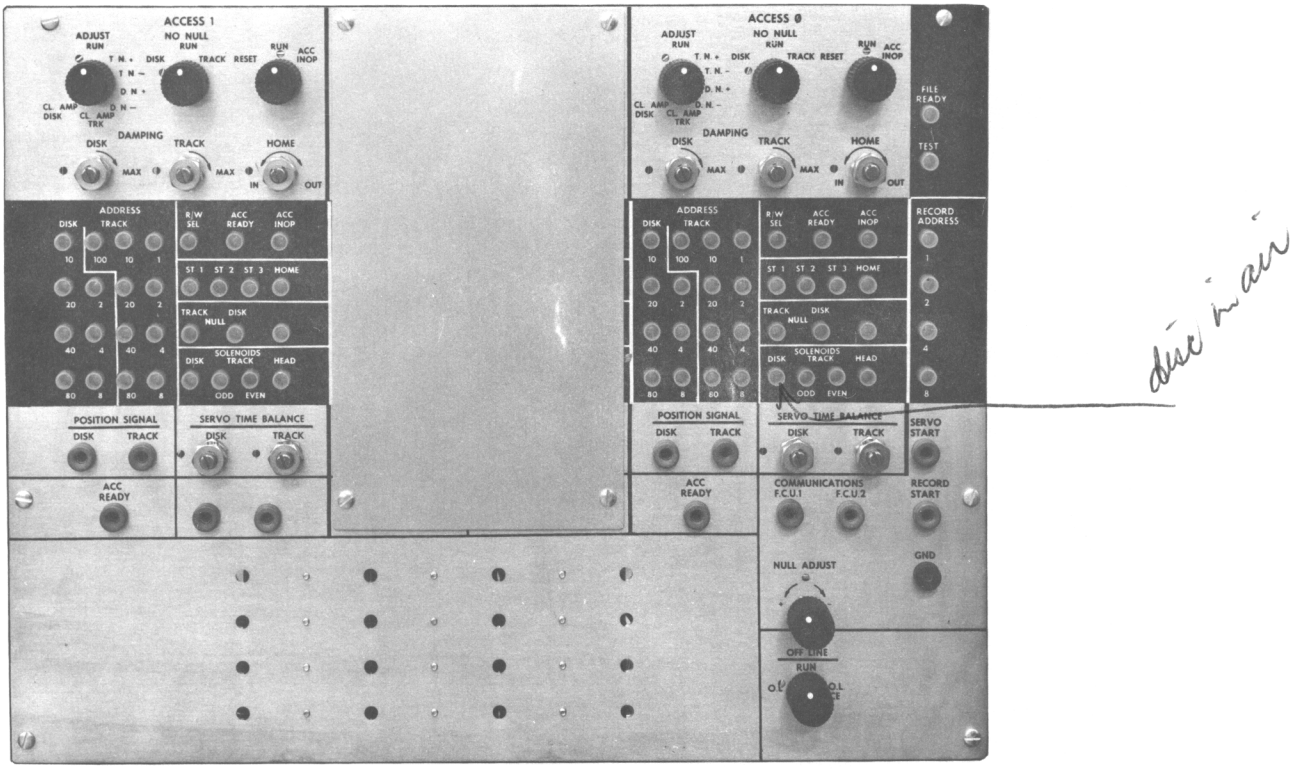


Figure 4-7. CE Test Panel

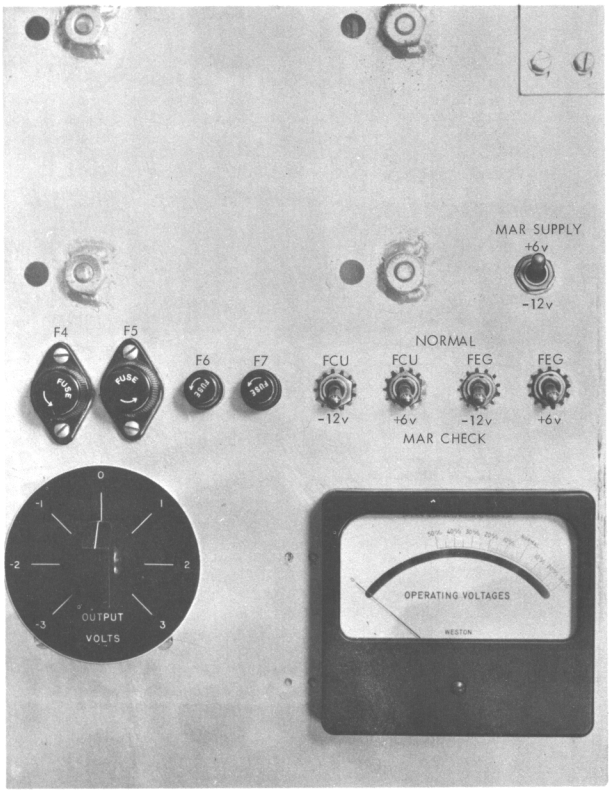


Figure 4-8. SMS Marginal Voltage Controls

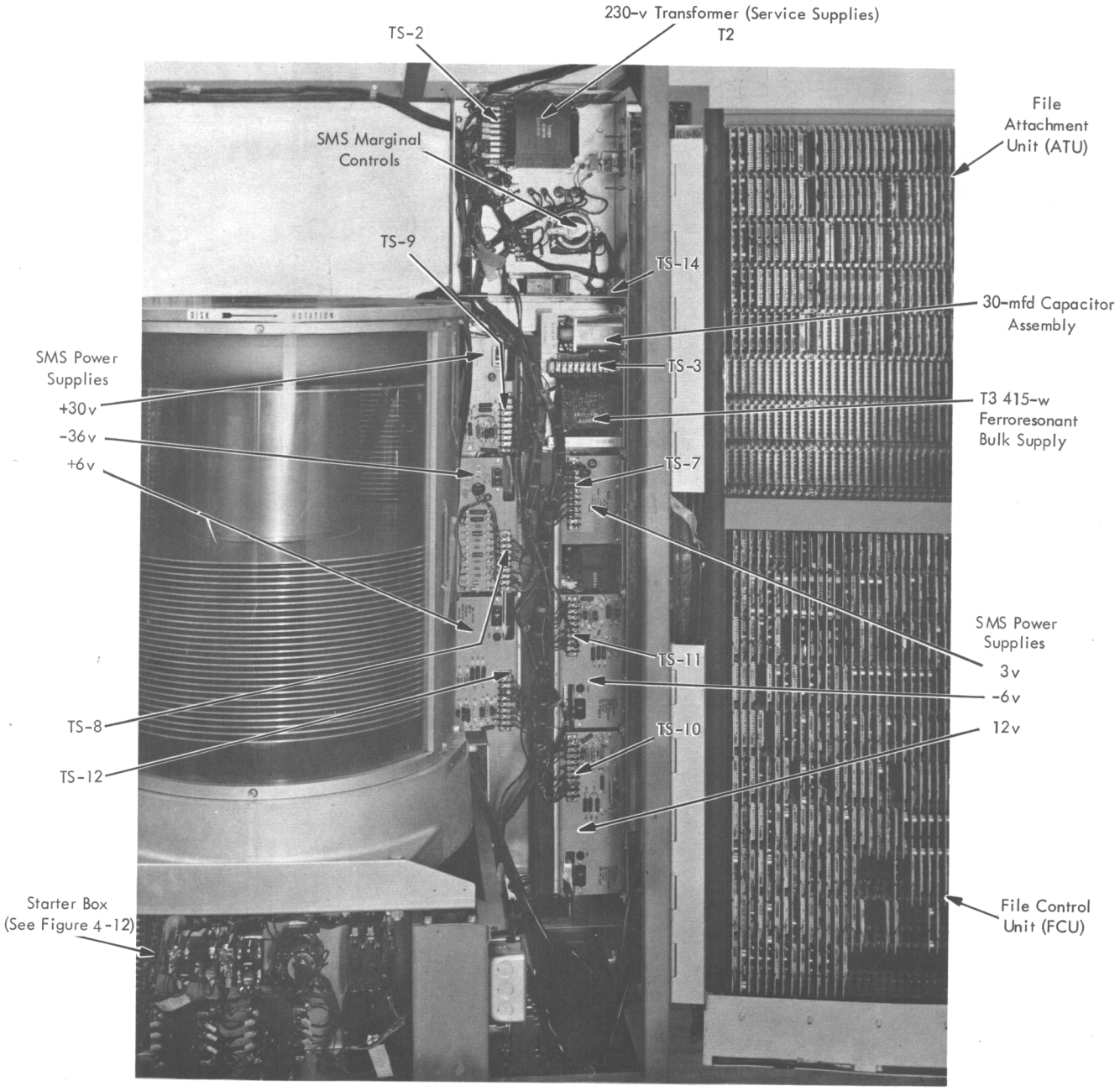


Figure 4-9. SMS Power Supplies

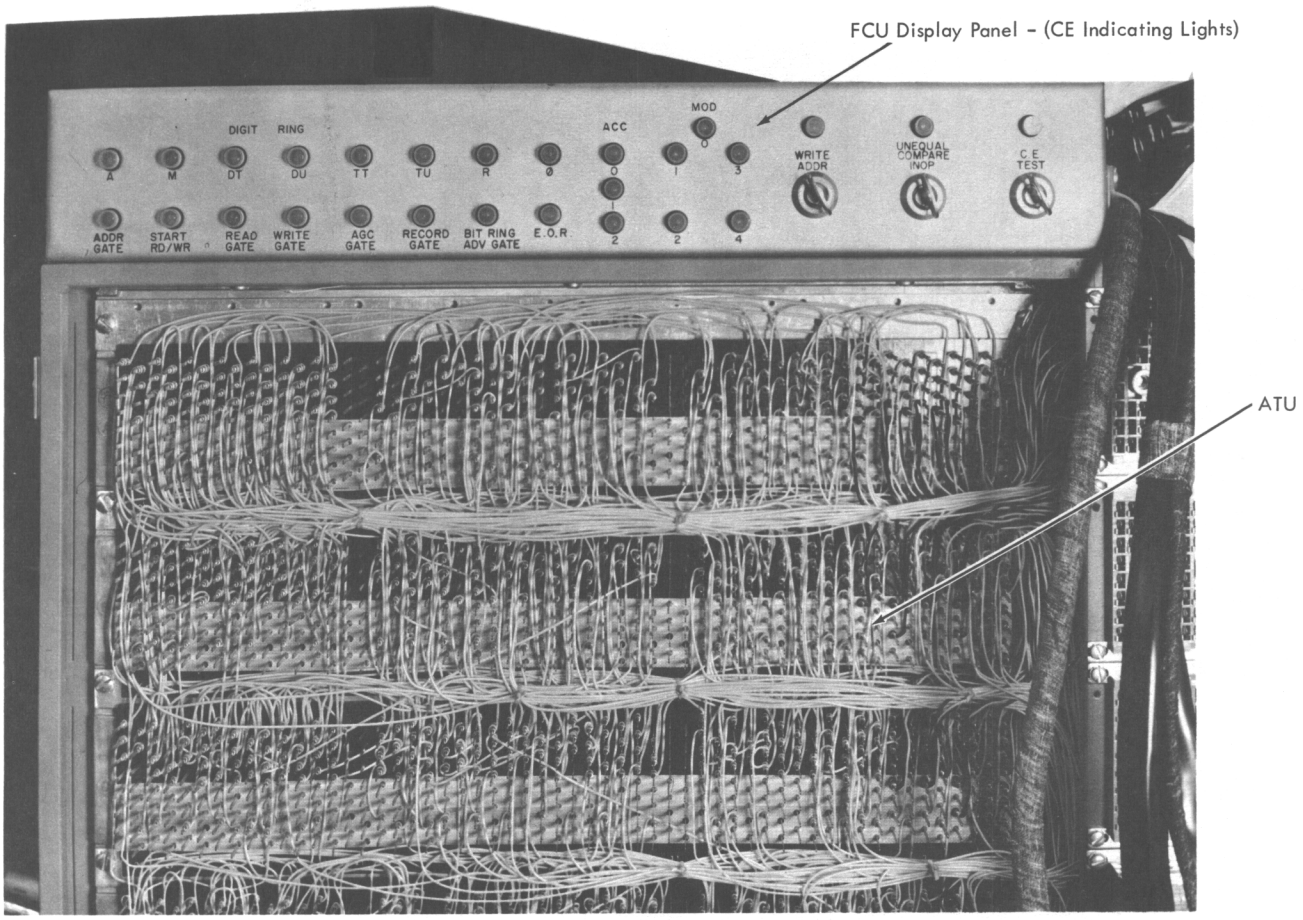


Figure 4-10. FCU Display Panel (Top Right-End Gate)

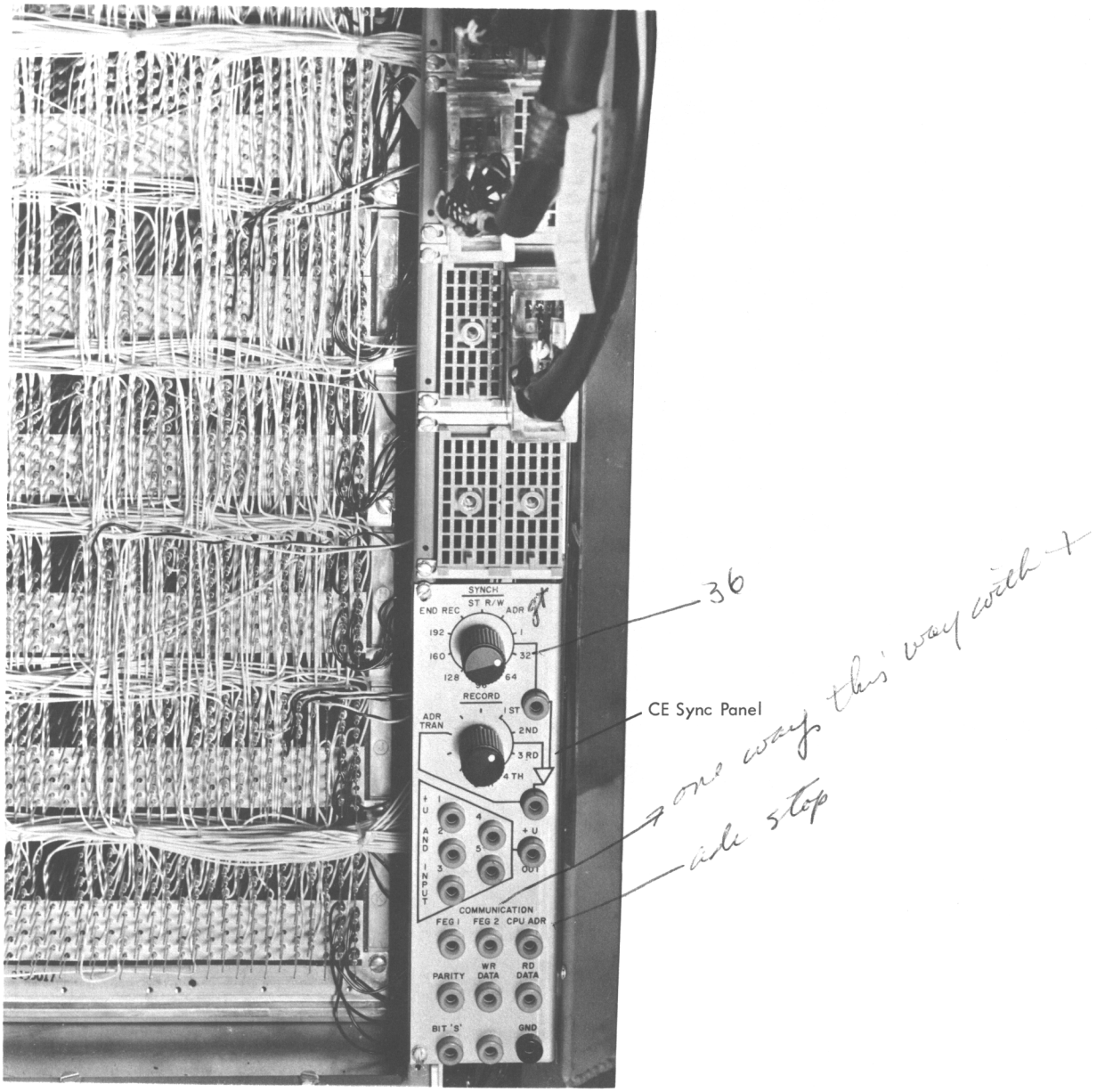


Figure 4-11. CE Sync Panel (Bottom of Right-End Gate)

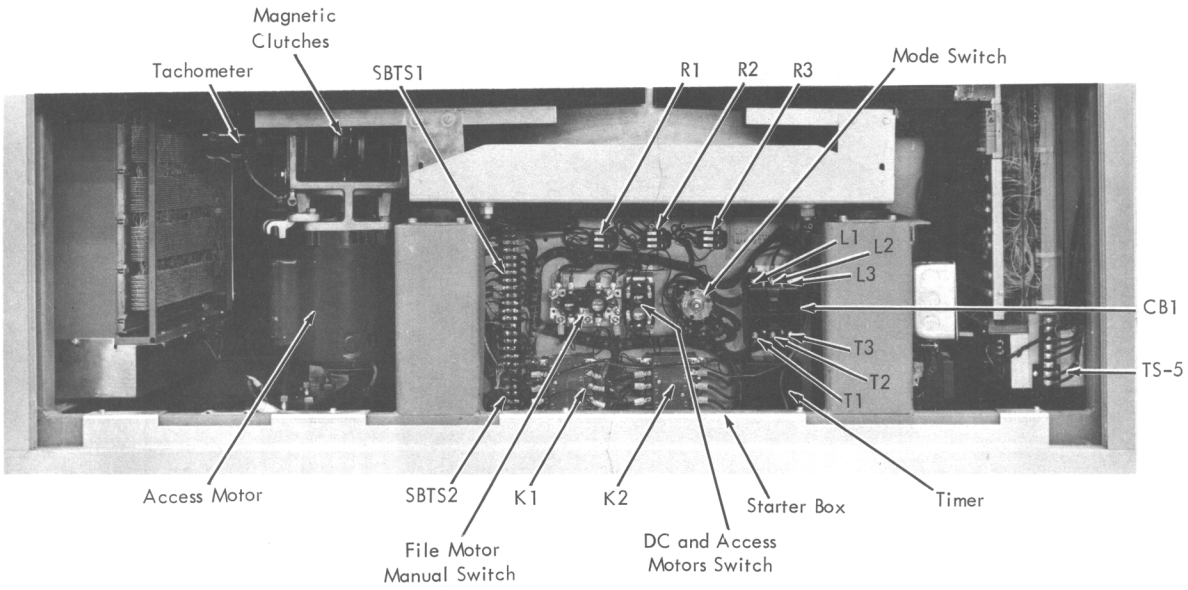


Figure 4-12. File Starter Box

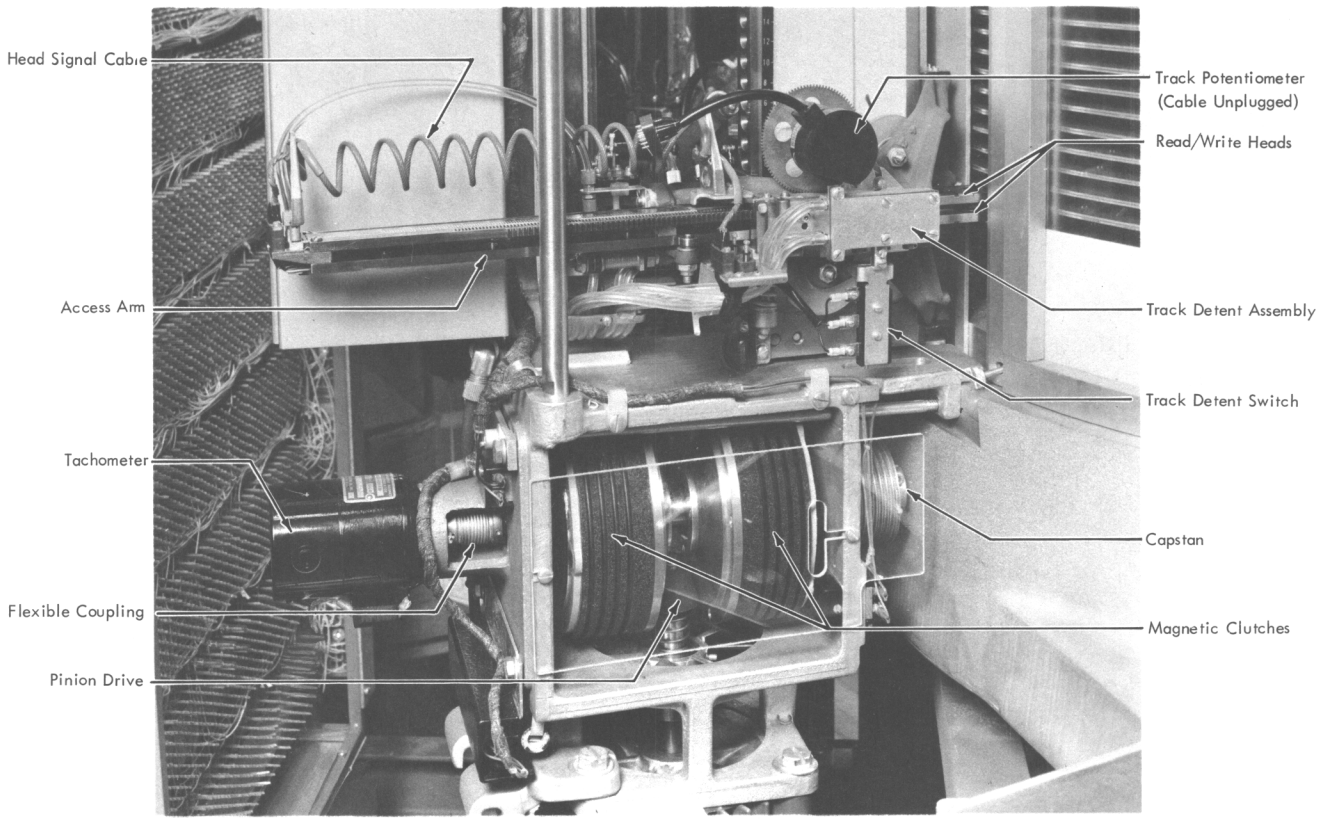


Figure 4-13. Access Mechanism

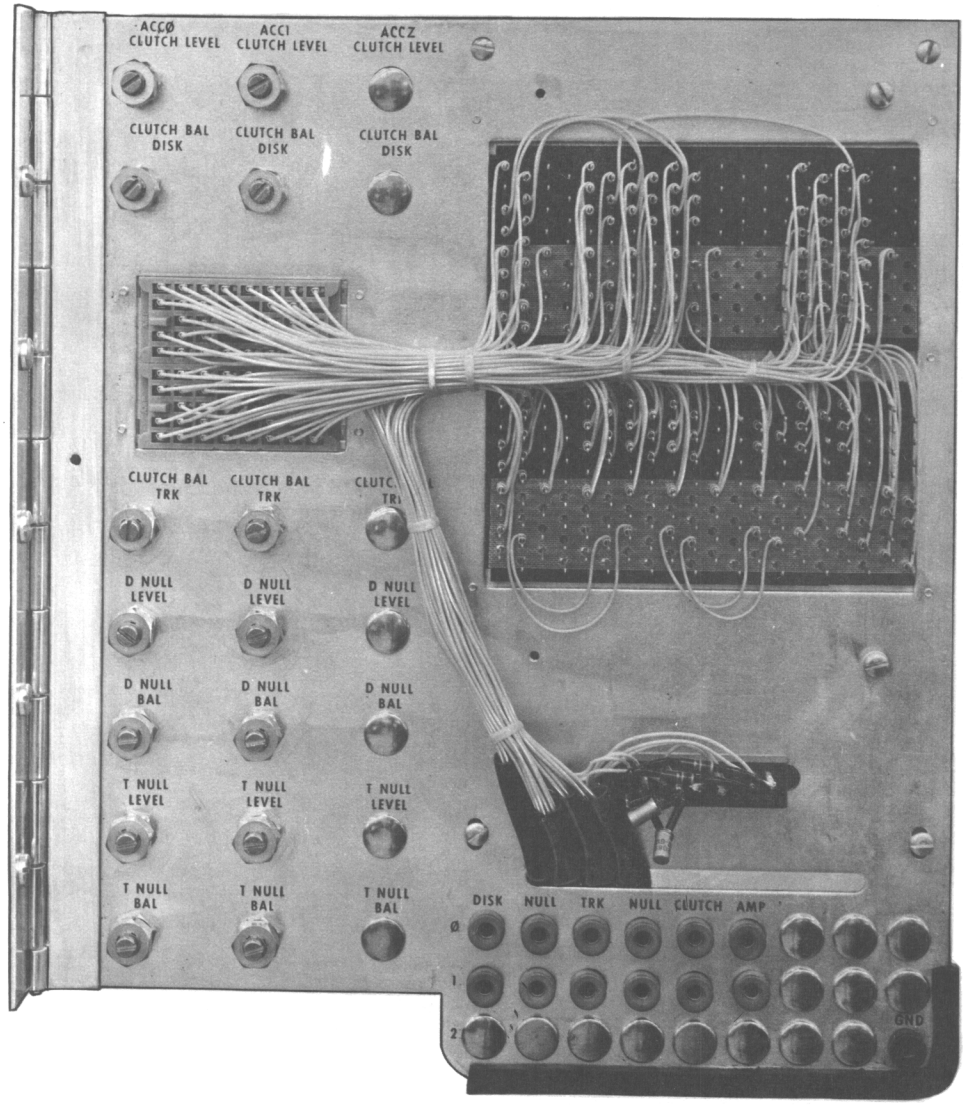


Figure 4-14. Card Heater Box (Servo Controls)

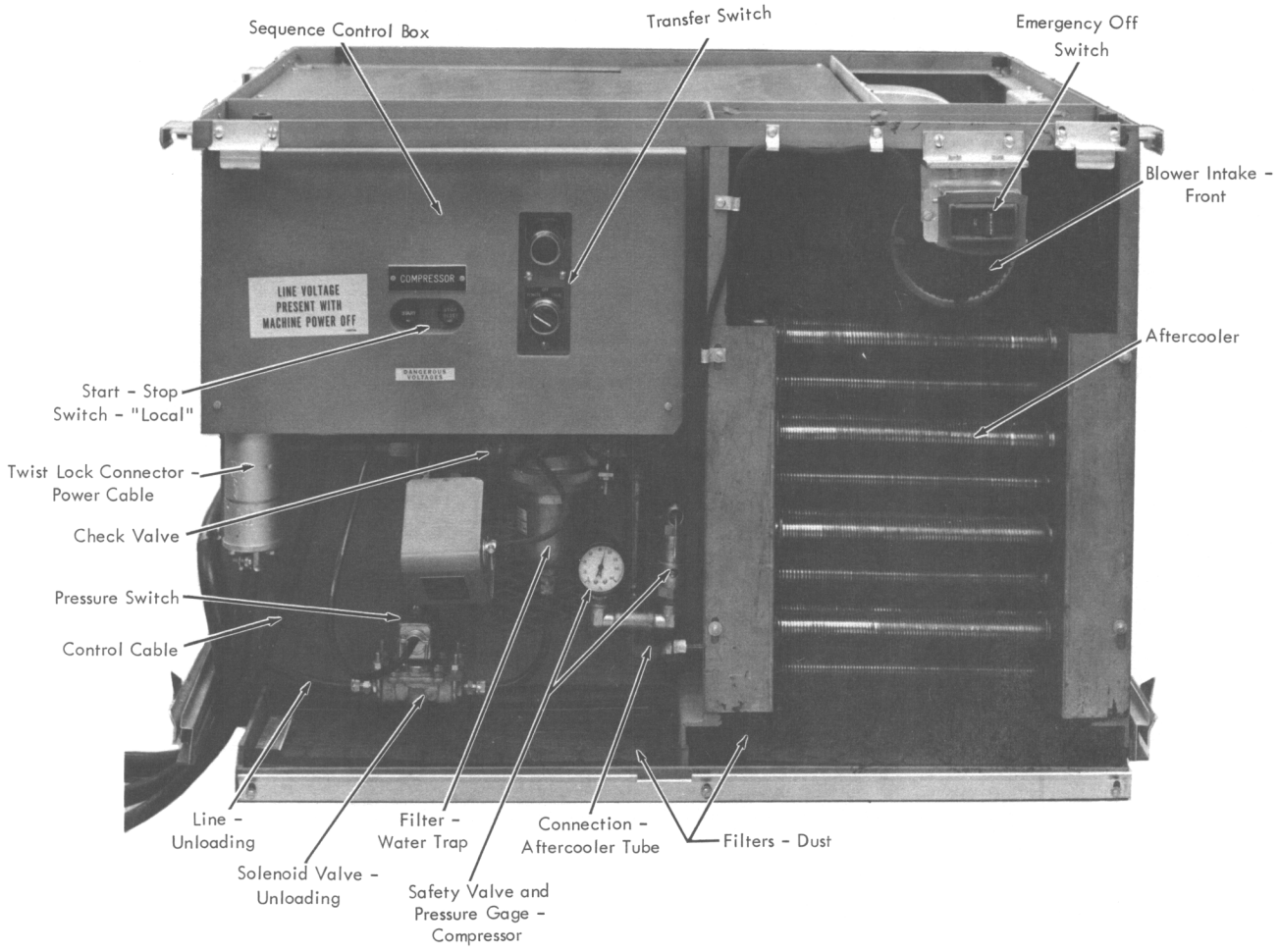


Figure 4-15. Remote Compressor (Front)

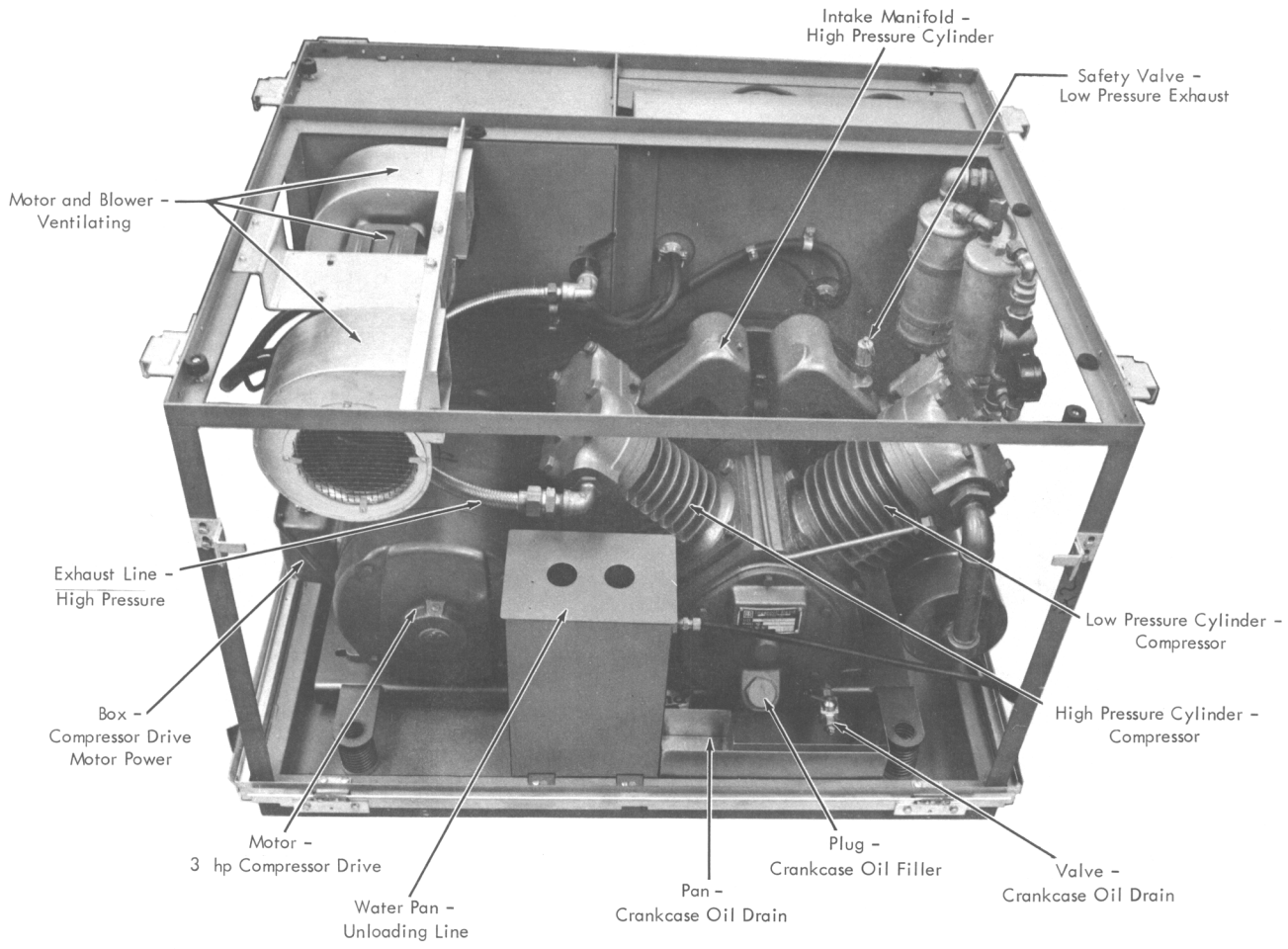


Figure 4-16. Remote Compressor (Top Rear)

Contents

1405 Synchronizing (Sync) Panel

In order to facilitate scope setup time, a synchronizing panel is located on the bottom (wiring side) of the right-end gate (Figure 4-11). An assortment of pulses and gates that are frequently used in triggering or gating the scope signal are available from hubs on this panel.

Format Sync Switch

This switch provides a sync point for triggering a scope at the beginning of Read/Write, at the beginning of the address, and at points spaced every 32 characters throughout the data record. These points can be used for triggering the scope to view read or write data, or raw data after the first preamplifier stage. The last position, End of Record, is used to check reset circuits and wrong length record conditions. The sync output, from the upper yellow hub, is a +U level.

Record Switch

This switch is used to provide sync points for full-track operations. The output of the Format Sync switch is ANDed with the record select circuit to provide a sync within any five records of the track. When this switch is in the "address transfer" position, a sync pulse is available at the beginning of address transfer time. The four remaining positions are empty. They may be used for other sync points as the occasion arises.

5-way AND

A 5-way AND block is provided to enable the Customer Engineer to select other sync points that may be required. All inputs must be at +U levels. The output is also at +U level.

Communication Lines

Two communication lines are provided to allow sync pulses to be sent to the CE hubs on the File Electronic Gate. These lines can only handle signals from the file control unit to the file electronics gate since they use line drivers and terminators. In a multiple file system, any signal fed into the communication hubs is available at the corresponding CE hub of all files in the system.

A third communications hub, CPU Adr., provides a sync pulse from the CPU when a program step uses the storage location whose address is set up in the CPU Manual Address switches.

Signal Hubs

These hubs provide the signals that are most commonly viewed on the scope. Isolation by means of convert blocks prevents possible scoping and ANDing errors from crippling the file control unit. The hubs are listed as follows:

1. Parity Error (used to detect missing and extra bits).
2. Write data.
3. Read data.
4. Bit S (used for blanking the scope and determining the beginning of a character).
5. Ground (reference for the scope).

CE Portable Test Unit

When properly connected, this unit functions to provide line signals and line levels to the file control unit to perform (off-line) all file operations for testing and checking purposes. The test box does not contain a clock or a power supply. The clock pulses and power are supplied by the file control unit through the 01C1YE cable.

The following procedure is used to properly connect the tester to the 1405:

WARNING: Whenever DC power is dropped or brought up, the 1401 must first be stopped to avoid the possibility of altering 1401 data.

1. Drop DC power to the 1405 (switch in file starter box).
2. Remove cables 01A1YE and 01A1YD from the ATU.
3. Install terminating block to connector 01A1YE. (This permits the use of the 1405 without the CPU.)
4. Connect the two removed cables, 01A1YD and 01A1YE, to the tester connectors D and E, respectively.
5. Restore 1405 DC power.
6. Push the Program Reset switch on the tester.

NOTE: When reading or writing with the CE tester, the CE Test switch should be on. All writing is restricted to CE tracks by CE interlock lines. However, reading may be done with the access at any address.

Switches (Figure 5-1)

Operation Switches

The Operation switches set the proper levels to the file control unit to perform one of the following operations:

1. Seek to a single record.
2. Alternately seek between two addresses.
3. Read a single record.
4. Write a single record.
5. Read a full track (5 records).
6. Write a full track (5 records).
7. Write an address (single record).

Mode Switch

The Mode switch sets the speed of an operation in the following manner.

1. *Single Cycle Position.* Each depression of the Start switch advances the digit ring one position and transfers one character of the address. At digit 7 time the operation is executed at 1405 clock speed.
2. *I-Execute Position.* This mode corresponds to an instruction execute cycle from the CPU. The timing sequence of an operation is allowed to run through the digit ring once.
3. *Run Position.* In this mode, the operation will be performed at 1405 clock speed. The operation will be repeated each time it is completed.

"A" Register Address Switches

These switches are used for all operations.

"B" Register Address Switches

These switches are used only on a seek-repeat operation. The access servos between the two addresses set up in the A and B register address switches.

Bit Switches

The bit switches provide a means of writing any bit configuration on the file.

Write Interlock/Disk Write

This switch corresponds to the Disk Write switch on the CPU. When it is in the OFF position, the normal write operation is set up but a write gate is not developed.

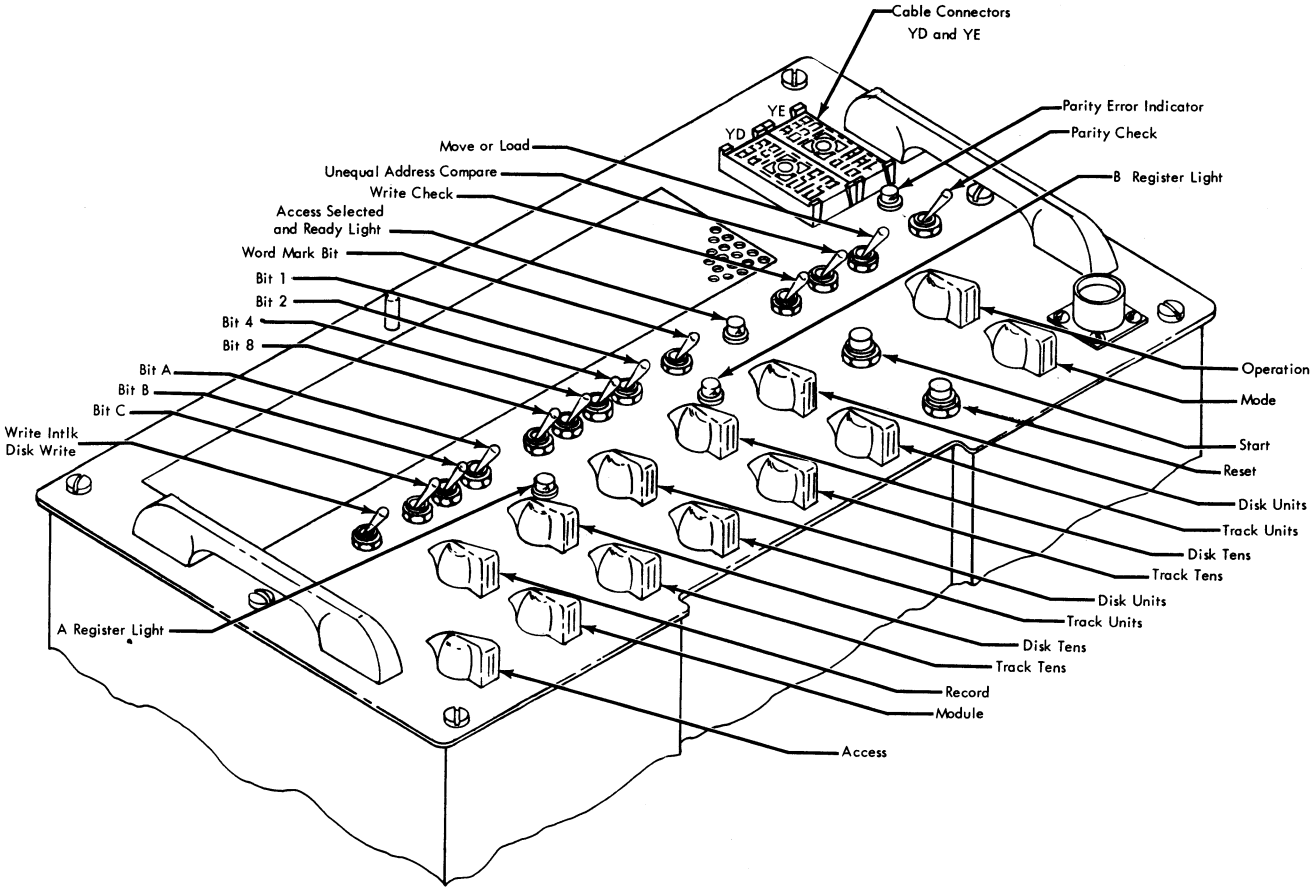


Figure 5-1. Operating Switches, CE Portable Tester

Condition Checking Switches

1. *Write Check.* This switch allows the CE Tester to simulate a read-back check operation.
2. *No Address Compare.* This switch forces a no address compare condition to permit the checking of the file control unit circuits.

Parity Switch

When the parity switch is transferred, the 1405 character register is sampled for odd parity. An even bit count will turn on the parity light.

Latches and Triggers

Address Transfer Latch

When an operation is started, the address transfer latch turns on at digit 0 phase C time and is reset at digit 7 time. This latch provides a "begin Op reset" to the FCU.

Selected Ready Latch

This latch is set at phase B time when the access is selected and ready. It is reset at digit 4 time when "ready" is dropped.

Single Cycle Latch

This latch, when on, opens the gate to the Digit Ring Advance trigger. It is turned on at phase D time when the address transfer latch is ON. It is turned off at the following phase B time.

Digit Ring Advance Trigger

In the RUN mode of operation, the Digit Ring Advance trigger allows the clock pulses to generate address strobes, address check strobes, and digit ring advance pulses in proper sequence .The trigger also acts as a frequency divider using every other phase A clock pulse to simulate CPU clock timing during address transfer time.

Start Latch

This latch provides at 3 to 5 μsec manual start pulse when the Start key is pressed.

Run Trigger

If the operation is performed in the RUN mode, this trigger provides a start pulse at each "end Op."

Write Latch

This latch is set at start time to allow a write operation if the Read/Write heads are over a CE track. It is reset 2.5 μsec after "end Op."

Read Latch

This latch is set at start time to allow a read operation to be performed over any track. It is reset 2.5 μsec after "end Op."

File Control Unit Display Panel

The lights on the display panel are service aid indicators. If failures occur, they indicate the condition of the principal latches, gates, and triggers. They are arranged in the order of their occurrence from left to right.

Special Tools

Factory Supplied

The following is a list of special tools that are sent with the machine from the factory. These tools are kept at the installation.

Item	*Part Number*
Air line service assembly	2108006
Disk cleaning paddle	2108010
Head cleaning kit	2108311
Adapter, gram gage	2108075
Bottle for 4 oz. Isopropyl alcohol (70% or better)	2108055
Box, plastic kit	2108312
Brush	2108025
Cloth, tool carrier	2108313
Drill No. 56	450037 or 2108018
Dropper	2108021
Nipple cover, arm air inlet	2108023
Oscillator adj. tool	451554
Plastic tube tool	2108305
Plate, test .125"	2108024
Tissue, cleaning	2108036
Tweezer	2108014
Wire, Music	2108016
Wire probe holder	2108316
Jumper assembly, CE Test (3)	2124599

Office Tools

The following tools are normally located in the Branch Office and can be obtained when needed.

Item	*Part Number*
Tester, CE portable	2108330
Disk replacement tool kit	2108268
Adapter, hex socket	2108040
Bolt, pull down (3)	2108041
Crutch tip	2108051
Tool assembly, disk installation	2108027
Tool, disk aligning	2108570
Tool, disk positioning	2108314
Washer ⅜" (3)	45740
Wrench, torque	2108039