IBM Field Engineering

Maintenance Manual

2310 Disk Storage

IBM®

Field Engineering Maintenance Manual

Issued to: _____

Branch Office: _____

Department: _____

Address: _____

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

2310 Disk Storage

PREFACE

This manual contains preliminary information. Users of this manual are cautioned that specifications are subject to change at any time and without prior notice by IBM. Wiring diagrams (logics) at the engineering change level for a specific machine are included in each machine shipment.

The scope of this manual is limited to the Disk Storage Drive. The machine is installed in a stand alone unit for IBM 1800 Data Acquisition and Control System, and is an integral part of the storage system of the IBM 1130 Computing System, physically located within the IBM 1131 Central Processing Unit.

This information consists of maintenance instructions which enable the CE to rapidly diagnose equipment malfunctions in the Disk Storage Drive and perform corrective maintenance to keep the equipment in a state of readiness for the customer. The CE must have completed prior IBM training for this equipment, and must be familiar with practical applications of the maintenance concept and techniques derived from training.

Alternate procedures are provided in a supplement in the back of this manual for machines with serial numbers 00001 through 00050.

Content of this manual is divided into seven chapters.

Chapter 1 contains instructions and procedures for diagnosing and isolating equipment malfunctions by the use of service aids and functional checkout procedures.

Chapter 2 describes switches and controls used by the CE to accomplish checkout and maintenance operations.

Chapter 3 contains instructions for performing scheduled maintenance and includes a tabulated schedule for accomplishing periodic maintenance operations.

Chapter 4 provides instructions for service checks, adjustments, and removal and replacement of components.

Chapter 5 provides a listing of power requirements and power sequencing.

Chapter 6 contains information which enables the CE to locate components, major assemblies, meters, gages, etc., which are described by the instructions contained in the manual.

Chapter 7 consists of a supplement which provides alternate procedures applicable to machines with serial numbers 00001 through 00050.

The companion publication, IBM Field Engineering Manual of Instruction 2310 Disk Storage (Form 227-5985-1) provides information for the theory of operation, and may be used as a reference to augment information contained within this manual.

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, Calif. 95114

CONTENTS

CHAPTER 1 DIAGNOSTIC AIDS 1.1
1.1 Diagnostic Techniques 1.1
1.2 Functional Check 1.1
1.3 Read Malfunctions 1.1
1.3.1 Read Circuit Troubleshooting 1.1
1.4 Write Malfunctions 1.2
1.4.1 Write Circuit Troubleshooting 1.2
1.5 Access Malfunctions 1.4
1.5.1 Access Circuit Malfunction Troubleshooting ... 1.4
1.5.2 Detent Assembly and Rack Troubleshooting ... 1.4
1.6 Base Plate Component Malfunctions 1.6
1.6.1 Troubleshooting Base Plate Components 1.6
1.7 Service Aids 1.6
1.7.1 Track Addressing 1.6
1.7.2 Disk Formatting Procedure 1.6
1.7.3 Error Retry Procedure 1.7
1.7.4 Homing the Carriage 1.7
1.7.5 Errors and Data Retrieval 1.7

CHAPTER 2 MAINTENANCE FEATURES 2.1
2.1 Leading Particulars 2.1
2.2 CE Disk Cartridge 2.1
2.3 CE Control Panel 2.1
2.4 CE Switches 2.1
2.4.1 Head Select Switch 2.1
2.4.2 Step Mode Switch 2.1
2.4.3 Direction Switch 2.2
2.4.4 Step Control Switch 2.2
2.5 Tools and Test Equipment 2.3
2.5.1 Standard Tools 2.3
2.5.2 Special Tools 2.3
2.5.3 Branch Office Tools 2.3

CHAPTER 3 SCHEDULED PREVENTIVE MAINTENANCE PROCEDURES 3.1
3.1 Approach to Scheduled Preventive Maintenance 3.1
3.1.1 Visual Inspection 3.1
3.1.2 Electronic Circuits 3.1
3.1.3 Mechanical Units 3.1
3.1.4 Cleanliness 3.1
3.2 Scheduled Maintenance Procedures 3.1
3.2.1 Cleaning Read/Write Heads 3.1
3.2.2 Lubrication of Machine 3.1
3.2.3 Drive Belt Tension Adjustment 3.4
3.3 Head and Disk Cartridge Scratch Description 3.4
3.3.1 Particle Damage to Disk 3.4
3.3.2 Particle Damage to Head 3.4
3.3.3 Non Particle Damage 3.4
3.3.4 Disk Cartridge and Read/Write Head Damage... 3.4

CHAPTER 4 SERVICE CHECKS, ADJUSTMENTS, AND REMOVAL PROCEDURES 4.1
4.0 Index of Service Checks, Adjustments and Removals .. 4.1
4.1 Drive Motor and Drive Belt 4.2
4.1.1 Drive Belt Removal and Replacement 4.2
4.1.2 Drive Motor Removal and Replacement 4.2
4.1.3 Spindle Assembly Removal and Replacement .. 4.2
4.2 Cartridge Assembly 4.2
4.2.1 Cartridge Service Check 4.2
4.2.2 Visual Inspection 4.3
4.2.3 Disk Height and Run Out Check 4.3
4.2.4 Disk Cartridge Replacement Conditions 4.4
4.3 Plenum Air Filter 4.4
4.3.1 Plenum Filter Flow Test 4.4
4.3.2 Plenum Air Filter Removal and Replacement ... 4.4
4.4 Blower Assembly 4.4
4.4.1 Blower Assembly Removal and Replacement ... 4.4
4.4.2 Blower Wheel Removal and Replacement 4.4
4.4.3 Blower Scroll Removal and Replacement 4.5
4.4.4 Blower Motor Removal and Replacement 4.5
4.5 Actuator Assembly 4.5
4.5.1 Actuator Assembly Removal and Replacement .. 4.5
4.5.2 Access Adjustments 4.5
4.6 Drive Magnet and Coil 4.9
4.6.1 Drive Magnet Removal and Replacement 4.9
4.6.2 Drive Coil Removal and Replacement 4.10
4.7 Detent Assembly and Detent Rack 4.10
4.7.1 Detent Assembly Removal and Replacement ... 4.10
4.7.2 Detent Assembly Adjustment 4.10
4.7.3 Detent Rack Removal and Replacement 4.10
4.7.4 Detent Rack Adjustment 4.12
4.8 Head Load Assembly 4.12
4.8.1 Head Load Solenoid Removal and Replacement .. 4.12
4.8.2 Head Load Assembly Adjustment 4.12
4.8.3 Heads Loaded Switch Removal, Replacement, and Adjustment 4.14
4.9 Head Load Spring Assembly 4.14
4.9.1 Head Load Spring Assembly Removal and Replacement 4.14
4.10 Crash Stops 4.14
4.10.1 Front Crash Stop Adjustment 4.14
4.10.2 Rear Crash Stop Adjustment 4.14
4.11 Home Switch 4.14
4.11.1 Home Switch Removal and Replacement 4.14
4.11.2 Home Switch Adjustment 4.14
4.12 Tachometer and Tachometer Extension Rod 4.14
4.12.1 Tachometer Extension Rod Removal and Replacement 4.14
4.12.2 Tachometer Extension Rod Adjustment 4.15
4.12.3 Tachometer Assembly Removal and Replacement 4.15
4.13 Carriage Rail 4.16
4.13.1 Carriage Rail Removal and Replacement 4.16
4.14 Carriage Preload Bearing Assembly Removal and Replacement 4.16
4.14.1 Carriage Preload Bearing Assembly Removal and Replacement 4.16
4.15 Carriage Subassembly 4.16
4.15.1 Carriage Subassembly Removal and Replacement 4.16
4.16 Read/Write Heads 4.17
4.16.1 Read/Write Head Service Check 4.17
4.16.2 Read/Write Head Replacement 4.17
4.16.3 Read/Write Head to Base Plate Resistance Check . 4.17

4.17 Head-Arm Assembly 4.17
4.17.1 Head Arm Assembly Adjustment 4.17
4.17.2 Head Arm Assembly Removal and Replacement 4.17
4.18 Cartridge Receiver 4.19
4.18.1 Cartridge Receiver Removal and Replacement 4.19
4.18.2 Cartridge Receiver Adjustment 4.19
4.18.3 Cartridge In Place Switch Adjustment 4.20
4.19 Interlocks 4.20
4.19.1 Handle and Interlock Adjustment 4.20
4.20 Sector Transducer 4.22
4.20.1 Sector Transducer Index Timing Adjustment .. 4.22
4.20.2 Sector Transducer Removal and Replacement 4.24
4.21 Data Separator 4.24
4.21.1 Data Separator Adjustment 4.24

CHAPTER 5 POWER SUPPLY 5.1
5.1 Power Requirements 5.1
5.1.1 AC Input Supply Power 5.1
5.1.2 DC Input Supply Power 5.1
5.2 Power Sequencing 5.1
5.2.1 Power On Sequence 5.1
5.2.2 Power Off Sequence 5.1
5.3 Power Line Interface 5.1
5.3.1 Input Power Lines to Disk Storage Drive 5.1

CHAPTER 6 LOCATIONS 6.1
6.1 General 6.1

CHAPTER 7 SUPPLEMENT FOR ALTERNATE MAINTENANCE INSTRUCTIONS 7.1
7.1 Purpose of Supplement 7.1
7.2 Alternate Maintenance Features 7.1
7.2.1 Identification of Machines 7.1
7.2.2 Special Tools 7.1
7.2.3 Branch Office Tools 7.1
7.3 Plenum Cover and Filter 7.1
7.3.1 Plenum Cover Removal and Replacement 7.1
7.3.2 Plenum Air Filter Removal and Replacement .. 7.1
7.4 Blower Assembly
7.4.1 Blower Assembly Removal 7.2
7.4.2 Blower Motor Removal and Replacement 7.2
7.5 Actuator Assembly 7.2
7.5.1 Actuator Assembly Removal and Replacement 7.2
7.6 Drive Magnet 7.3
7.6.1 Drive Magnet Removal and Replacement 7.3
7.6.2 Drive Magnet Adjustment 7.4
7.7 Detent Assembly and Detent Rack 7.4
7.7.1 Detent Assembly Removal and Replacement .. 7.4
7.7.2 Detent Assembly Adjustment 7.4
7.7.3 Detent Rack Removal and Replacement 7.5
7.7.4 Detent Rack Adjustment 7.6
7.8 Head Load Assembly 7.6
7.8.1 Head Load Solenoid Removal and Replacement 7.6
7.8.2 Head Load Assembly Adjustment 7.6
7.9 Head Load Spring Assembly 7.9
7.9.1 Head Load Spring Assembly Counterbalance Spring Adjustment 7.9
7.10 Crash Stops 7.9
7.10.1 Rear Crash Stop Adjustment 7.9
7.11 Home Switch 7.9
7.11.1 Home Switch Removal and Replacement 7.9
7.11.2 Home Switch Adjustment 7.9
7.12 Tachometer and Tachometer Extension Rod 7.10
7.12.1 Tachometer Extension Rod Removal 7.10
7.12.2 Tachometer Extension Rod Adjustment 7.10
7.12.3 Tachometer Assembly Removal and Replacement 7.11
7.13 Carriage Rail 7.11
7.13.1 Carriage Rail Removal and Replacement 7.11
7.14 Carriage Subassembly 7.11
7.14.1 Carriage Subassembly Removal and Replacement 7.11
7.15 Head-Arm Assembly 7.12
7.15.1 Head-Arm Assembly Adjustment 7.12
7.16 Cartridge Receiver 7.13
7.16.1 Cartridge Receiver Removal and Replacement 7.13
7.16.2 Cartridge Receiver Adjustment 7.13
7.17 Interlocks 7.15
7.17.1 Handle and Interlock Adjustment 7.15
7.18 Sector Transducer 7.15
7.18.1 Sector Transducer Index Timing Adjustment .. 7.15

INDEX I.1

Personal safety cannot be overemphasized. To ensure your own safety, make it an every day practice to follow safety precautions at all times. Become familiar with and use safety practices outlined in IBM cards, Forms 124-0002 and MO4-8401, issued to all Customer Engineers.

AC Power

The Start and Stop switches on the IBM 2310 Disk Storage Drive do not apply and turn off ac power to the machine but simply energize and de-energize the spindle drive motor. Caution must be exercised when servicing the machine since objects can contact 110/220-volt connections despite the safety shields and covers provided.

Isopropyl Alcohol

Use only IBM approved 91% Isopropyl Alcohol (P/N 2155966) for cleaning of read/write heads. Other types may cause damage and/or contamination due to impurities. The 91% isopropyl alsohol solution is a flammable liquid, therefore, keep only the quantity needed for impending use in the customer's office.

Keep the plastic bottle containing isopropyl alcohol in the sealed metal container except when in use.

When shipping 91% isopropyl alcohol, comply with the appropriate regulations (noted on the container) for shipment of flammable liquids.

WARNINGS: There are many ways in which the 2310 Disk Storage Drive can be damaged by improper operation or improper servicing techniques. These are described in the text under the appropriate servicing procedure. The most significant of these are listed below.

Disk Cartridge Handling

Cleanliness must be maintained while handling the disk cartridge. The cartridge door which receives the read/write heads must never be unlatched and opened when the cartridge is out of the machine except when using the disk cartridge cleaning fixture to clean disk. Also, the air valve located on the bottom surface of the cartridge must never be opened. Serious damage to disk surfaces could result if foreign particles are introduced inside the cartridge.

Never disassemble a disk cartridge. The disk cartridge assembly is a permanently encased unit which cannot be disassembled without damage.

The disk cartridge should never be stacked or otherwise subjected to top loading. Nor should it be stored on a protruding object. Handling practices of this nature could result in deforming the diaphragm which effects centering of the disk within the cartridge housing. Damage to the diaphragm will render the cartridge unusable and could cause damage to read/write heads.

Disk Cartridge Insertion into Machine

DC power must always be on before insertion of the cartridge. The machine is interlocked so that when dc power is on, and ac power is turned off, the carriage returns to home position. If the cartridge is inserted without first turning on dc power, the carriage could be in some position other than home, and the cartridge could strike the heads. The machine contains interlocking switches which prevent this condition from occurring unless the Customer Engineer violates or overrides the safety function of these switches.

CE Restricted Tracks on Disk Cartridge

Do not write on the CE disk cartridge at tracks 90 through 110. This band contains prerecorded test tracks 95, 100, and 105 which will be destroyed. Any other tracks may be used for test purposes.

Read/Write Heads

Avoid touching the gliding surface of read/write heads. Acids from the skin can etch and ruin the head.

Do not load leads manually when a cartridge is out of the machine, when disk is stopped, or when blower system is not operating. If it becomes necessary to load heads under these static conditions, a folded IBM card should be inserted between the heads to protect gliding surfaces from possible damage. Read/write heads must be cleaned immediately whenever this is done.

Machine Operation

Head loading precautions must be observed when operating the machine. Proper operation of the machine is to provide ac and dc power to energize the blower

system and home the carriage. The cartridge is then inserted, and the receiver handle is raised to lower the cartridge onto the spindle. Power is applied to the disk drive motor and the spindle will come up to speed.

If power is applied to the disk drive motor without a cartridge present, the cartridge in place switch can be manually operated to energize the motor to effect loading of heads; however, a folded IBM card should be inserted between the heads for protection.

DC Power

The +3 vdc, —3 vdc, and +6 vdc power must be applied to, and removed from, the machine at the same time to prevent damage to internal circuits of the 2310 Disk Storage Drive. The +48-vdc power must never be applied without all other dc voltages being present.

Tachometer Cable Removal

Turn off dc power before removing the tachometer cable. If this is not done, accessing may be uncontrolled with resulting damage to the access mechanism.

1.1 DIAGNOSTIC TECHNIQUES

WARNING: Voltage is present on both sides of most circuit cards. Metal caps of transistors are often a part of the circuit. Avoid pulling or replacing cards with the d-c power on, since a resultant short circuit could damage transistors or other components in the circuit.

WARNING: A potential of +48 volts is present for head pick, cartridge lock, access amplifier, and voltage regulator circuits. A potential of +36 volts is present for write circuits. Exercise care when probing near SLT cards containing these circuits to avoid possible shorts which could result in extensive damage.

Intermittent problems can sometimes be aggravated by vibration. Tapping the edge of cards with the plastic handle of a screwdriver in the area suspected should be sufficient. Use caution because excessive vibrations can cause a short circuit in adjacent card components.

Conditions will arise where it is desirable to jumper in signals or voltages to specific inputs or outputs to check certain functions. Care should be taken to ensure that logic blocks are not overloaded during these checks, as erroneous indications will result. More important, avoid the use of high voltages which can damage or destroy the transistors. For the majority of logic block cases, a properly placed ground will create the effect desired. All other cases must be treated individually based on knowledge of the circuits involved.

Special circuit card diagrams are shown in the system diagrams. Also shown are input and output waveforms for most of these cards.

When the electronic gate is opened to check the positioning of SLT cards, care should be taken to properly replace the SLT card support before closing the gate. This support serves to rigidly brace the outer edges of the cards with the gate housing to minimize card vibration. The support normally interferes with the bottom of the electronic gate to provide a preload on ends of the SLT cards.

1.2 FUNCTIONAL CHECK

The functional check provides for operating the equipment without using signal control circuits of the Central Processing Unit (CPU). This check verifies that the drive actuator, carriage access motion, head selection, and start/stop equipment functions will perform as required.

The CE control panel contains switches which become active only when the CE Interlock signal cable between system control and the IBM 2310 is disconnected. Upon disconnecting this cable from system control circuits, the disk storage drive is automatically placed in a read select mode to prevent inadvertent erasure of recorded data, and to allow the CE to examine the read circuit and recorded data. The functional check is to be accomplished as follows:

NOTE: No CE check is provided on the 2310 for writing information.

1. Remove CE Interlock signal cable.
2. Ensure ac and dc power is available to machine.
3. Install CE cartridge.
4. Energize drive motor.
5. Using CE switches, access carriage and select each head to determine that machine operates satisfactorily.

1.3 READ MALFUNCTIONS

1.3.1 Read Circuit Troubleshooting (Figure 1-1)

All read/write safety circuits in the machine are coupled with the write lock latch, which becomes set and produces a write select error signal when incompatibility exists at gated outputs from read/write lines. Always check the write driver SLT card when neither read nor write operations function.

When the Write-Lock latch becomes set, File Ready condition is removed from the machine, and the carriage will access to home position (track 000) and stop while the disk will continue to rotate.

It will be necessary to turn off power to the drive motor to reduce disk speed to 30 RPM to reset the latch -- then power up the machine to attain a File Ready status.

WARNING: Do not put scope probes, leads, or jumpers of any kind on lines comming directly from read/write heads. The heads can be damaged and/or data destroyed by the presence of voltages at these points.

The read circuits consists of read/write heads, the Preamplifier/Write Driver SLT Card, Read Amplifier SLT Card, and Data Separator SLT card. All cards are located in the electronic gate.

The preamplifier circuit provides a differential signal input to the read amplifier of 360 KC (all zero pattern) and 726 KC (all one's pattern). The output from the read amplifier is single ended, and provides double frequency data to the data separator SLT card. The read gate is the only gate required by the read amplifier.

A CE Test Point and is located on the read amplifier for CE use. Input to the amplifier differentiator circuit is measured at the CE Test amplifier, TP D2 G07. Output of the detector circuit is measured at pin location D2 B03.

The voltage at TP D2 G07 should be 1.5 v minimum to 3.15 v maximum. This voltage will vary with respect to the track being read. A higher voltage will prevail at the outside track than at the inside track because of the difference in disk surface speed relative to the read/write head.

The following analysis is to be used to troubleshoot read circuits: Oscilloscope display patterns for read/write circuits are shown in Figure 1-1.

Both Heads in 2310 Fail to Read - Probable causes:

1. Heads not loaded. Check visually.
2. Carriage at incorrect cylinder to read disk. Check visually.
3. DC voltage supplies not at a correct level. This is an unsafe condition. Check interlock SLT card. In a read select mode, the write lock latch should be set.

NOTE: Voltages should be checked at the SLT board.

4. Head not selected, or both heads selected. Check head select line (+3 v level for head zero and ground level for head one).
5. Data separator circuit has improper output. Check for Read Clock output on C2 D03 and Read Data output on C2 D05.
6. Read amplifier has no output. Check for output signal at detector circuit on read amplifier SLT card at location D2 B03.
7. Read amplifier has no input. Check for presence of input signal at Amplifier Differential circuit on read amplifier SLT card at CE Test Point TP D2 G07.

2310 Reads But Generates Read Errors - Probable Causes:

1. Machine fails to read on a particular head:
   a. Head select transistor for this head is inoperative. Check write driver SLT card for malfunction of head select transistors.
   b. Line noise present in read signal. Check that head-arm assembly is electrically isolated from frame ground.
   c. Open head diode(s). Replace preamplifier/write driver card.
   d. Disk speed detection output fluctuates. Check for sector time of 5 ms between pulses. Possible that speed detector is defective.
   e. Data separator circuit defective -- does not provide Read Clock output at C2D03 and/or Read Data output at C2D05. Check data separator adjustment of 600 nsec single shot which gates between clock pulses to permit data pulses to pass.
   f. Head shoe dc resistance relative to base plate should be 5 ohms or less.
   g. Intermittent short between coils, or between coils and ground of read/write head.
   h. Heads improperly aligned to read track.
2. Machine makes frequent read errors on a particular head.
   a. Disk Speed detector output fluctuates. Check for defective speed detector.
   b. Weak read signal at head. Check for improper loading of head against disk surface. Check for defective head. Check for improper force on head-load spring.
   c. Head shoe dc resistance relative to base plate should be 5 ohms or less.
   d. Bad head. Check for presence of read amplifier output at pin location D2B03.
   e. Intermittent open in head diodes. Replace preamplifier/write driver SLT card.
   f. Intermittent head select. Check write driver SLT card for malfunction of head select circuit.
   g. Head is out of alignment. Check alignment of read/write head with CE track 100.

1.4 WRITE MALFUNCTIONS

1.4.1 Write Circuit Troubleshooting (Figure 1-1)

NOTE: An apparent failure to write can be caused by a write select error condition when the Write Lock

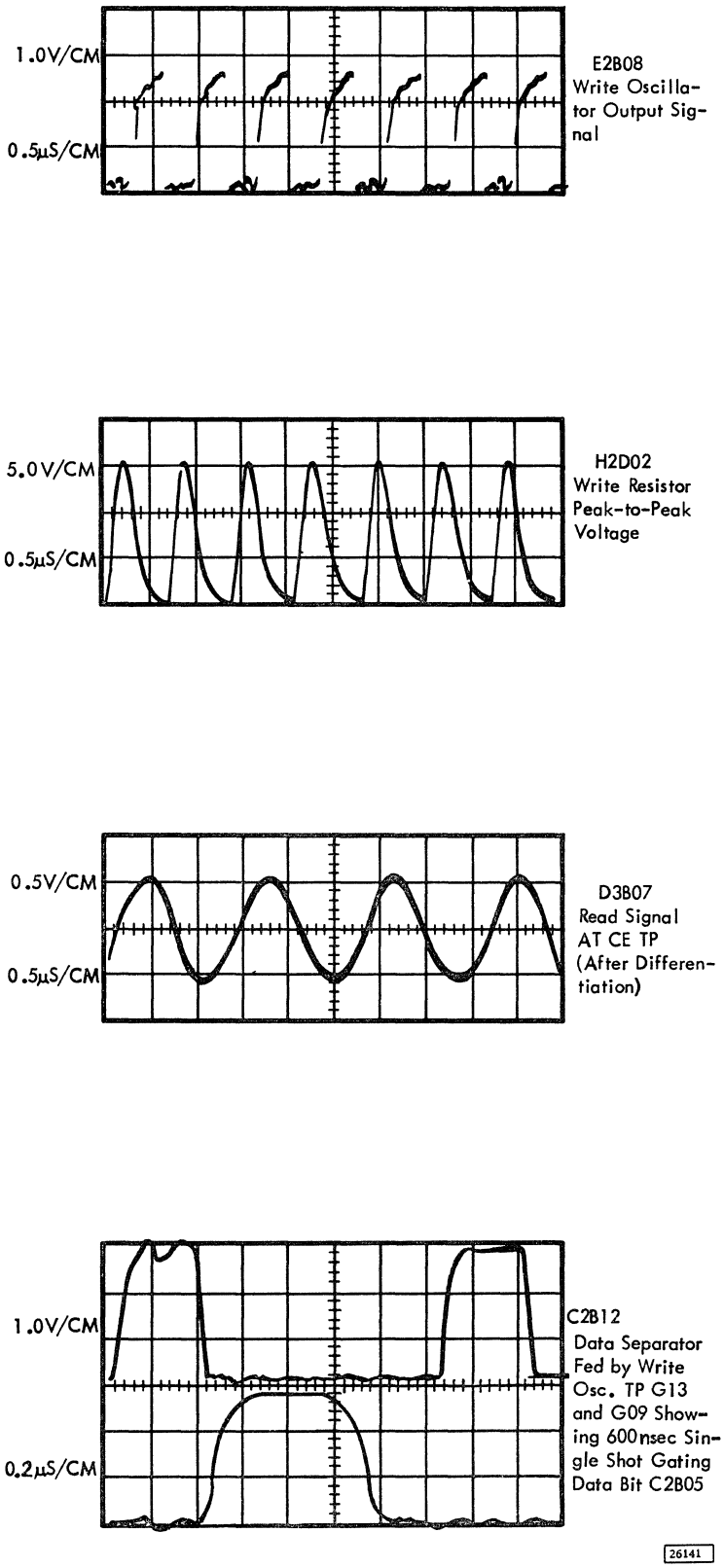


Figure 1-1. Oscilloscope Display of Read/Write Circuits

latch becomes set because of a read/write circuit malfunction. Check for a latched condition in the read/write safety circuit before investigating the write driver SLT card or read/write head for trouble. Refer to section 1.3.1 which lists machine status conditions caused by setting of this latch.

Information to be written is supplied to the 2310 via the write data line. The writing process is under complete control of the system control circuits. The machine is conditioned to write when the Write Gate line and Write Clock Gate line are at ground level.

The write circuits consists of read/write heads, Preamplifier/Write Driver SLT card, Write Select Safety SLT card, and 1.44 Mc Oscillator and Trigger SLT card. All cards are located in the electronic gate.

The write amplifier furnishes the write driver with three lines: Write Gate, Write Data, and a 1.44 MC Oscillator Signal Line. The nominal dc voltage of the write signal at the heads is +26 volts.

The following analysis is to be used to troubleshoot write circuits:

Both Heads in 2310 Fail to Write - Probable Cause:

1. Heads not loaded. Check visually.
2. Write gate is not at the correct level to allow write data to enter the machine. The write gate line should be at ground level for write and erase circuits to be turned on.
3. Write resistor voltage to read/write head is insufficient. Peak-to-peak voltage across the write resistor should be 15 volts.

2310 Generates Write Errors - Probable Causes:

1. Intermittent write driver or write amplifier.
2. Output of write amplifier on write data lines is incorrect.
3. Write resistor voltage into the head is insuffi cient. Peak-to-peak voltage across the write resistor should be 15 volts.

1.5 ACCESS MALFUNCTIONS

1.5.1 Access Circuit Malfunction Troubleshooting

The access circuits contain the Access Amplifier SLT card, Access Logic SLT card, tachometer assembly, and detent mechanism. These circuits and components effect control of detent operation, duration of drive current, and dynamic braking of carriage motion.

Whenever malfunction is suspected in accessing circuits, the following four adjustments are to be accomplished according to procedures of Chapter 4:

1. A deadband adjustment is accomplished to minimize carriage oscillations when the carriage is decelerated to arrive at a new track location.
2. A 10 milli-inch and 20 milli-inch integrator set adjustment is made to calibrate the trip level for decelerating and stopping carriage motion within limits for a single step increment. A separate adjustment is made for each stepping mode.
3. A 10 ms single shot adjustment provides for timing of the detent to correctly seat in the rack after the carriage has been accessed to a new track location.
4. A dynamic balance adjustment is made to obtain smooth detent operation for both directions of carriage travel between track 000 and track 200.

Some of these adjustments are inter-related, and it will be necessary to perform a complete adjustment whenever a single adjustment is disturbed, or whenever a new SLT card is substituted in the access circuits during troubleshooting. Oscilloscope display patterns for access circuits are shown in Figure 1-2.

1.5.2 Detent Assembly and Rack Troubleshooting

No adjustment of the detent assembly is made other than initially locating the assembly against the rack and establishing a clearance of 0.006 (±0.001) inch between the clapper and pole piece while the electromagnet is energized. The CE cartridge can be used to check odd-even detent operation by comparison of the signal on track 100 with the signal on track 105 to determine that spacing between tracks is within acceptable limits. A check of detent operation is made as follows:

1. With the CE Cartridge installed, allow 15 minutes for temperature of the cartridge to stabilize with temperature of the machine.
2. Use the CE switches to access the carriage to CE track 100 and verify that heads are aligned properly with this test track. The even detent will be engaged at this track location.
3. Access the carriage to CE track 105 and verify that heads are still aligned properly with the test track. The odd detent will be engaged at this track location.

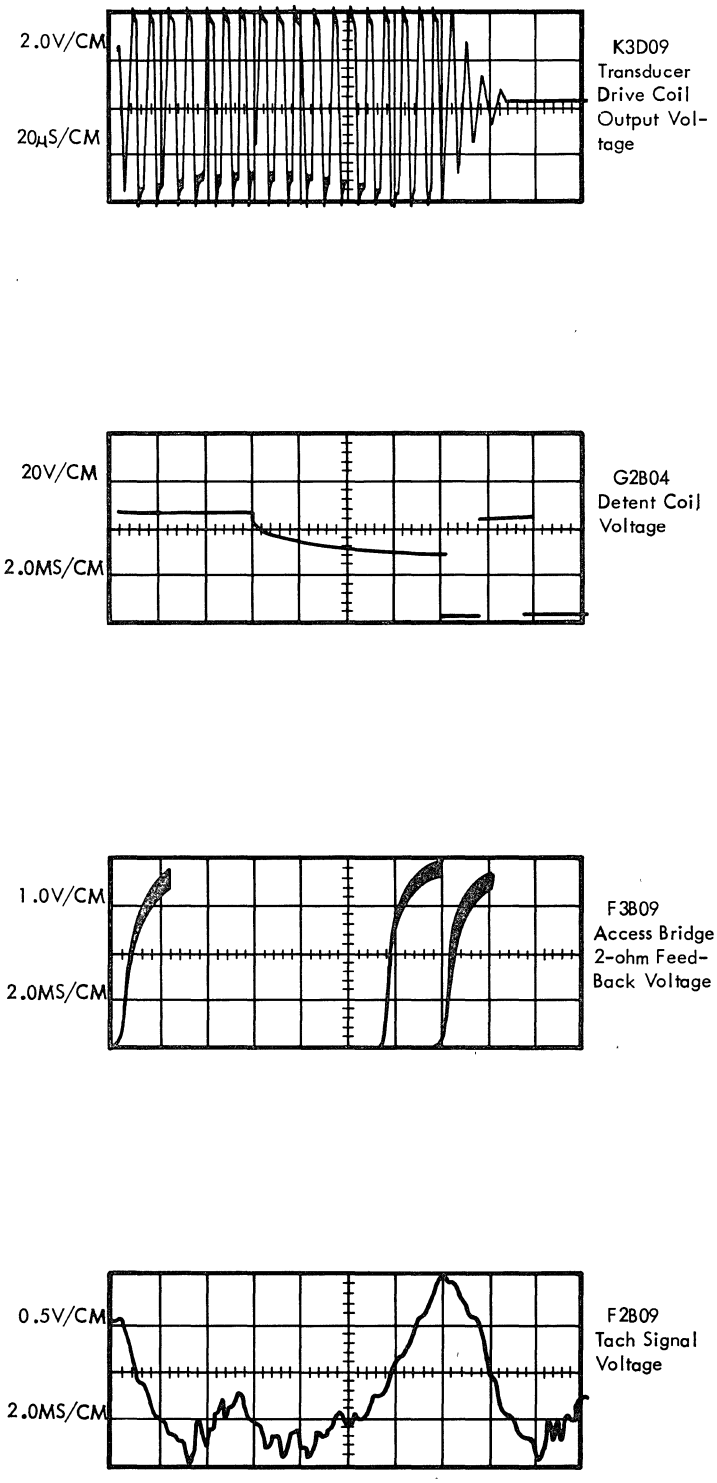


Figure 1-2. Oscilloscope Display of Access Circuits

NOTE: It may be necessary and is permissable to apply a slight pressure against the front or rear of the carriage to check head alignment at this track location.

4. Verify that the same head alignment signal pattern is displayed at both track locations (100 and 105). A discrepancy in signal patterns denotes that the spacing between detents is not within allowable limits.

1.6 BASE PLATE COMPONENT MALFUNCTIONS

1.6.1 Troubleshooting Base Plate Components

The following procedure is to be used to check components of the base plate.

1. Remove cover by removing two retaining screws located on cartridge-guide posts and lift cover from the machine.
2. Check Sector transducer signal lines for good connections. Check to determine that slots in sector ring and transducer are free from build up of foreign obstructions.
3. Check for 0 to 5-ohm resistance when measured between the dc gate ground and the base plate.
4. Check spindle and drive belt for proper tension.
5. Check detent mechanism to determine that even detent is fully engaged at home position (track 000) and that odd detent is not engaged but is evenly aligned with crest of detent rack.
6. Check detent rack for cleanliness.
7. Check head-load mechanism for non-binding movement.
8. Check read/write head flexure springs for tightness, and check head-load spring for proper contact with heads while heads are loaded manually on an IBM card.

1.7 SERVICE AIDS

These instructions provide for diagnosing machine malfunctions which interface with programming of the CPU. A Symptom Index (Figure 1-3) lists the applicable service Aids associated with machine failures of this type.

1.7.1 Track Addressing

Since the 2310 does not provide any carriage position information to the using system except in the Home position, hardware or programming errors in carriage positioning or head selection are not directly detectable. Therefore, it is imperative that the using system record address information on the disk either as part of the data field or in a separate address field along with each data record. This address must provide verification of the position of the selected information.

Symptom Index

Problem	Cause	C. E. M. Reference

26143

Figure 1-3. Sympton Index of Service Aids

1.7.2 Disk Formatting Procedure

Disk defects on new or used 2315 Disk Cartridges can effect data recording, causing loss of useable tracks, because of the high density recording of the disk cartridge. Using systems should therefore program storage capacities based on 200 data tracks, allowing three spare tracks to ensure that the stated capacities are maintained for the life of the cartridge. Whenever a 2315 Disk Cartridge is used in a 2310 installation, a customer utility program employing the following procedure is used to locate the defects, flag the tracks in error, and identify the alternate track locations. The procedure to be used is as follows:

1. Starting with head 0, track 000, the pattern 11100101 must be written and verified by a read operation.

2. Then the pattern 00010011 must be written and verified again.
3. If successful, the formatting procedure should be continued. However, if an error repeats itself ten times on either pattern, the track must be flagged and an alternate track address written.
4. To ensure that the alternate track is alright for use, it should be formatted immediately before continuing with the subsequent disk cartridge tracks. Use spare tracks in locations 200-202 for alternate tracks.

1.7.3 Error Retry Procedure

The IBM programming systems supporting the 2310, provide for a ten-retry procedure to be utilized on any failure of access or write. A fifty retry procedure must be used for read errors. In addition, an automatic track flagging procedure must be established in the file programs if errors occur during a write operation. In order to protect against machine read/write malfunctions as opposed to its defects, this formatting procedure should first skip to the alternate track to record this data. If errors occur at this new alternate track, the procedure should stop and request attention of the C.E. If, however, the recording at the alternate track occurs without error, the old track should be flagged, the alternate address recorded and the program should continue.

1.7.4 Homing the Carriage

When initializing the carriage to the Home position from an unknown location, the carriage must be decremented in single track steps. By testing for Home after each step, the program can determine when Track 000 has been reached. This can be accomplished by providing an access command to move the carriage 203 tracks, or more in a reverse direction so that carriage will access to home and stop. This will present an Access Home communication signal to the using system.

1.7.5 Errors and Data Retrieval

A sporadic increase in random errors can sometimes be corrected by cleaning the heads and disk cartridge using the scheduled maintenance procedure. A solid error during a customer program, caused by failure to read a record from the file properly, need not mean the loss of that data to the customer. If the trouble is pinpointed in the head disk area:

1. Thoroughly clean the heads using the scheduled maintenance procedure. Clean the disk using the Branch Office cleaning fixture and then try to read the data.
2. If the data cannot be read, examine the disk surface at the point in question for a comet trail and an imbedded particle. An attempt can be made to dislodge the particle by "scrubbing" the spot with lint-free tissue and a cleaning tool. Do not use any other method as serious disk damage can result.
3. Temporary replacement of the head may be tried, but make certain that the new head will not be damaged.
4. If all else fails, it may be possible to read the affected area on a scope trace as a final resort to recover the data.

2.1 LEADING PARTICULARS

Maintenance features of the IBM 2310 Disk Storage Drive include switches and controls which permit the CE to check and monitor operating characteristics of the machine in a read select mode during maintenance.

A CE disk cartridge is used by the Customer Engineer for radial alignment of read/write heads, and circumferential adjustment of the sector transducer.

Special tools are available at the branch-office level to properly service the machine and its components. A special Disk Cartridge Cleaning Fixture is used to clean read/write surfaces of the disk. A Disk Run Out Fixture is used to measure vertical deflection of disk surfaces.

2.2 CE DISK CARTRIDGE

The CE disk cartridge (P/N 2200001) can be identified by its red access door. (Customer disk cartridges are white all over.) The CE disk cartridge has three pre-recorded tracks on each side of the disk. These tracks are used for head-alignment tracking adjustment (track 100) and sector index timing adjustments (track 095). The third track, which checks detent spacing (track 105), is provided for future use and is not to be used for maintenance purposes. Care must be taken not to damage the pre-recordings contained on these tracks. Allowance is made for protection of CE tracks by avoiding the use of tracks 90 through 110. Any other tracks may be used by the CE for read/write maintenance applications.

The alignment of read/write heads is accomplished by using CE Track 100 which consists of two tracks. One of the tracks is written outboard from track 100, and the other is written inboard from track 100 so that eccentricity is built into the track. The two tracks are written with a clock pattern of all zeros at a frequency of 720 KC. Read/write heads are adjusted to read equal amplitudes of the two eccentric tracks. (Section 4.17.1)

The index timing is adjusted by the use of CE track 095. A burst of bits and an index pulse is recorded on this track. The sector transducer is positioned radially about the spindle so that a time delay of 30 (±5) μsec exists between the reference burst for an all-bits pattern and presentation of the index pulse.

2.3 CE CONTROL PANEL

A CE control panel located on back of the equipment (Figure 2-1) is provided to permit limited operation of the disk storage drive independent of the using system, except for power input. The CE switches located on the panel are normally inoperative and become active only when the CE Interlock signal cable between the using system and the disk storage drive is disconnected.

Disconnecting this cable, places the machine in a Read Select mode. The CE can examine the read circuit and recorded data without the possibility of erasing recorded information.

2.4 CE SWITCHES

Four CE switches are provided on the CE panel; Head Select switch, Step Mode switch, Direction switch, and Step Control switch. No CE control is provided on the 2310 for writing information.

2.4.1 Head Select Switch

The Head Select switch controls the selection of heads so that the CE may examine read signals originating from either head. This switch determines which of the two heads is in use, and is particularly useful when aligning heads to a CE cartridge. The switch has two positions, labeled 0 and 1, which correspond with the upper and lower read/write head.

2.4.2 Step Mode Switch

The Step Mode switch controls the actuator stepping mode by determining the distance to be traversed by

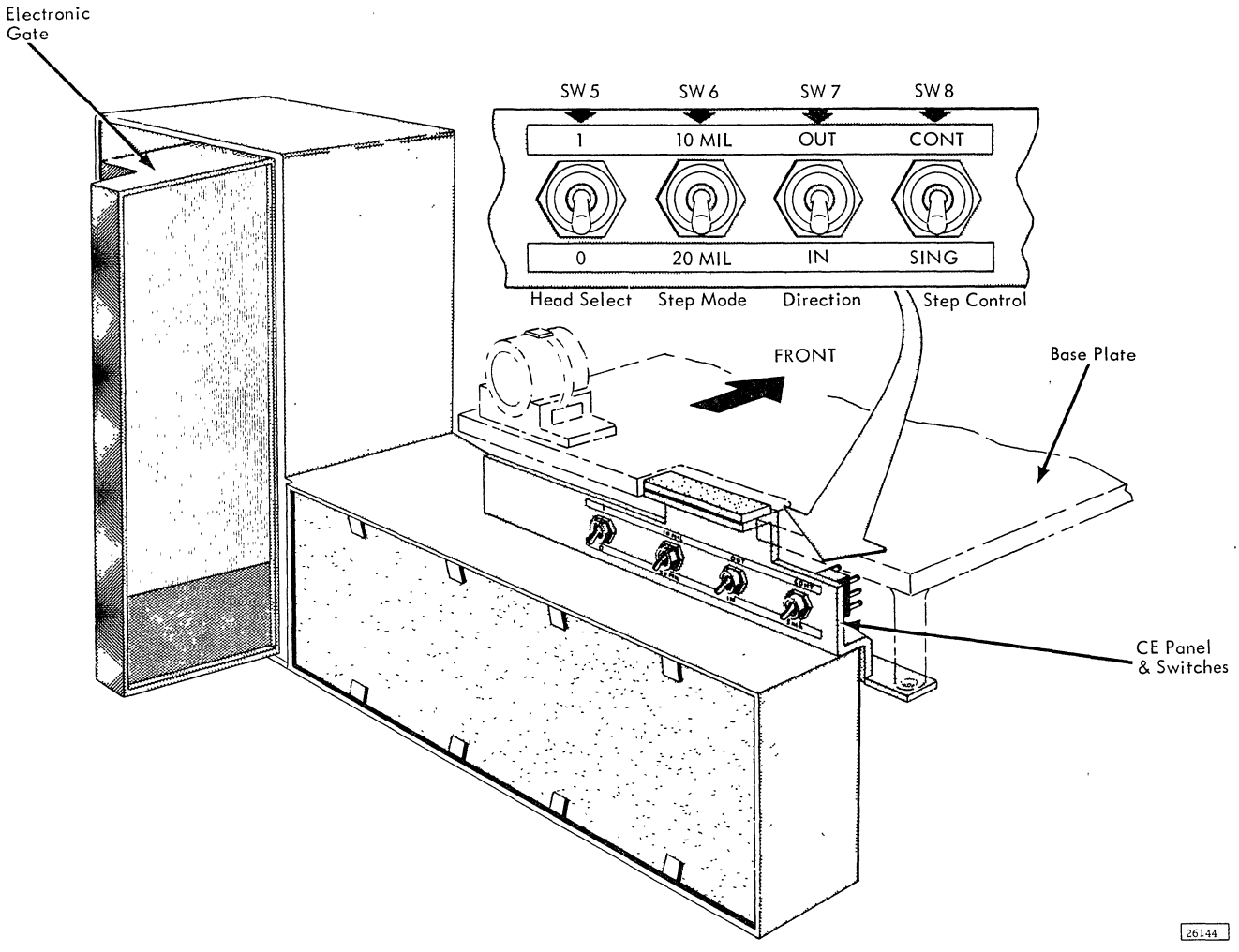


Figure 2-1. CE Panel and Switches

the carriage for each step of the actuator. The switch has two positions, labeled 10 MIL and 20 MIL, which correspond with the distance to be displaced by the carriage (10 or 20 milli-inches) each time the Step Control switch is actuated.

2.4.3 Direction Switch

The Direction switch controls the direction of carriage motion by causing the carriage to move in a forward or reverse direction while it is being actuated. The switch has two positions labeled IN and OUT. The In position causes the carriage to move forward toward the center of the data disk when the Step Control switch is actuated. The Out position causes the carriage to move, in reverse, away from center of the data disk each time the Step Control switch is actuated.

2.4.4 Step Control Switch

The Step Control switch initiates carriage motion by providing an access drive pulse to access circuits to effect movement of the carriage. This switch has three positions; continuous step, single step, and neutral. Labeling on the switch, CONT and SING, correspond with the continuous or single stepping movement.

When the switch is positioned for a continuous step movement, the actuator is caused to step continuously at a 15 ms rate in a forward or reverse direction as determined by the position of the Direction switch. The actuator steps in increments of 10 or 20 milli-inch steps as determined by the position of the Step Mode switch. The actuator continues this stepping cycle until the carriage strikes the mechanical limits of travel where the detent continues to

operate without carriage motion, or until the Step Control switch is removed from the Continuous step position.

When the switch is positioned for a single step movement, the actuator will move one step each time the switch is operated. The switch is spring loaded so that it will return to the neutral position when released. The direction of carriage travel, and 10 or 20 milli-inch step increment is determined by the respective positions of the Direction and Step Mode switches.

2.5 TOOLS AND TEST EQUIPMENT

2.5.1 Standard Tools

To properly service the equipment, the CE requires the following tools:

Small CE Tool Kit . . . . . (P/N 451558)
SLT Tool Kit . . . . . (Not available 9/65)
CE Oscilloscope, Type 561S with Indicator Unit . . . . . (P/N 451647)

The following oscilloscope attachments are required:

Plug-in Dual Trace . . . . . (P/N 451648)
Plug-in Time Base . . . . . (P/N 451651)

2.5.2 Special Tools and Supplies

The following special tools are required to service the equipment and are available in the shipping group for systems which use the disk storage drive.

Feeler Gage, non-magnetic (0.005 inch) . . . . . (P/N 2200007)
Feeler Gage, non-magnetic (0.007 inch) . . . . . (P/N 2200057)
Lint Free Tissue . . . . . (P/N 2162567)
SLT Board Jumper Wires . . . . (P/N 353796)
Alcohol, 91% Isopropyl, Pint Container . . . . . (P/N 2155966)
Head Alignment Oscilloscope Adapter . . . . . (P/N 2200052)

2.5.3 Branch Office Tools

The following is a list of tools and supplies which are normally located in the Branch Office. These tools can be obtained when needed.

CE Disk Cartridge . . . . . (P/N 2200001)
Cleaning Paddles . . . . . (P/N 2108474)

Disk Cleaning Fixture (P/N 2200008)

The disk cartridge cleaning fixture provides for cleaning the disk while it is encased within the cartridge. The operator unlatches the cartridge door and inserts the cartridge into the fixture so that cleaning pads span the data surfaces as disk is positioned on the spindle. The spindle can be rotated manually while cleaning solution is applied to the disk data surfaces. This fixture is used for unscheduled maintenance.

Disk Run Out Gage (P/N 2200050)*

The disk run out gage (Figure 2-2) enables the CE to determine the extent of warpage present in a disk by measuring the amount of vertical deflection present at the outer edge of the disk. This gage is mounted on the base plate, adjacent to the head-arm assemblies, so that the disk can be manually rotated between the gap established by adjustable lips of the gage. A knurled adjusting screw on the gage permits adjusting the gap size to determine runout. Procedures for using the gage are described in Chapter 4.

*Alternate procedures are contained in Chapter 7 for machines with serial numbers 00001 through 00050.

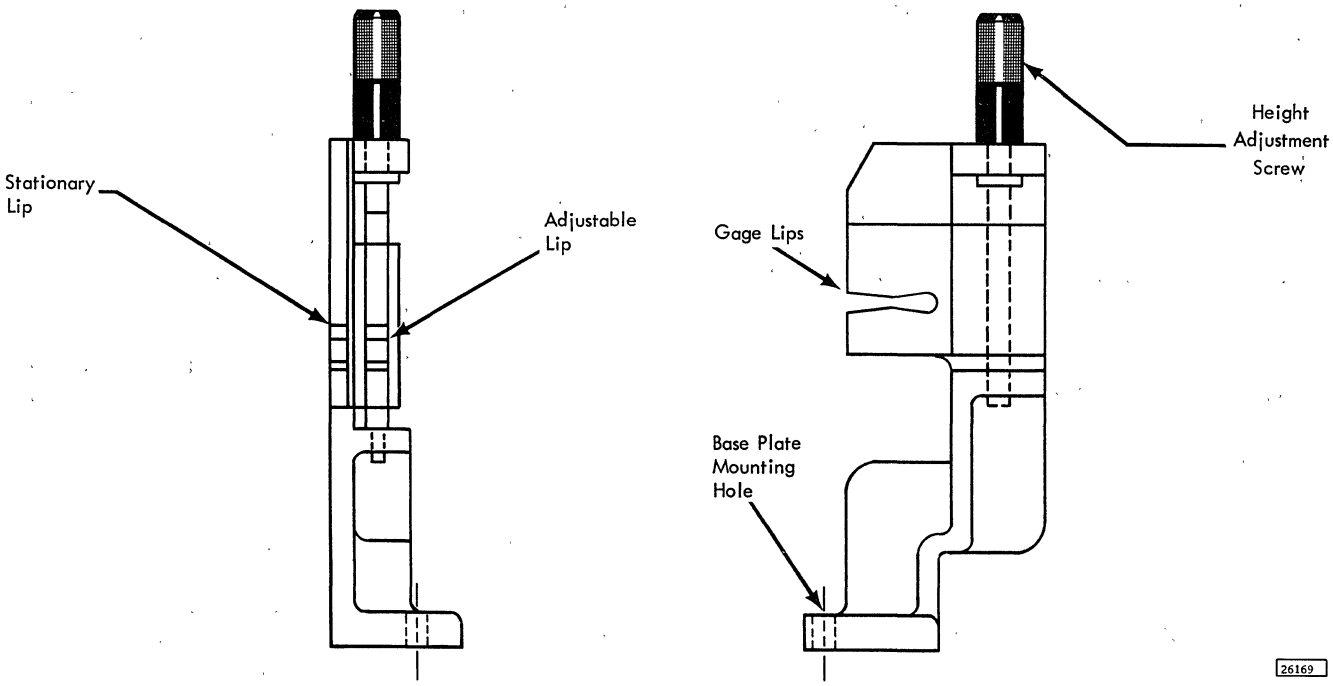


Figure 2-2. Disk Run Out Gage

3.1 APPROACH TO SCHEDULED PREVENTIVE MAINTENANCE

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

3.1.1 Visual Inspection

Visual inspection is the first step to every preventive maintenance operation. Always look for corrosion, dirt, wear, cracks, binds, and loose connections in wiring and on hardware. Alertness in noticing these items may minimize machine down time later.

3.1.2 Electronic Circuits

Diagnostic programs and pulse checking are the two basic tools used in preventive maintenance of electronic circuits. All of these are effective in locating potential and intermittent troubles. These items are also excellent troubleshooting tools.

3.1.3 Mechanical Units

The three basic preventive maintenance steps performed on every mechanical or electromechanical machine are clean, lubricate, and inspect. Remember, do not do more than recommended preventive maintenance on equipment that is operating satisfactorily.

3.1.4 Cleanliness

Cleanliness cannot be overemphasized in maintaining the IBM 2310 Disk Storage Drive.

When the heads are "flying" a clearance of approximately 125 to 150 microinches exists between the heads and the surfaces of the disk. Very small particles of dust can accumulate and become trapped between the heads and the disk. The accumulated dust can cause the disk surface to become scored, and this condition can result in an unusable track or in head damage.

Do not allow oil to accumulate anywhere on the machine. Oil accumulates dust and dirt. Do not operate the machine with the top cover removed unless analysis cannot be performed in any other manner. If the machine must run with the cover off, replace customer's cartridge with a CE cartridge to avoid damage to customer data.

3.2 SCHEDULED MAINTENANCE PROCEDURES

Details of scheduled maintenance operations are listed in Figure 3-1. During normal scheduled maintenance, perform only those operations listed on the chart for that particular maintenance period. The 2310 Disk Storage Drive scheduled maintenance period is defined by its time interval of use by the customer. Details on adjustments and service checks are found in the Operation column of Figure 3-1. Observe all safety practices.

3.2.1 Cleaning Read/Write Heads

1. Wrap a lint-free wiper (P/N 2162567) around a paddle and dampen with 91% isopropyl alcohol (P/N 2155966)

   NOTE: Paddle is made by folding an IBM card four to five times lengthwise.

2. Use a second paddle to support the back of a read/write head, and thoroughly wipe the face of each read/write head with the lint-free wiper dampened with alcohol. Use the dental mirror to inspect the head surface. Be very careful that all dirt is cleaned off. Any extraneous material which is not cleaned off will damage the disks. Finally, wipe head with dry wiper.

WARNING: Do not touch the face of the read/write head with fingers. Acids emitted from skin can etch and ruin a head. Do not leave any residue on face of the read/write head. Do not blow on heads. Moisture will rust and contaminate the heads.

3.2.2 Lubrication of Machine

Scheduled lubrication requirements for the 2310 are described in Figures 3-1 and 3-2. Specified lubricants are to be applied according to instructions contained in these charts.

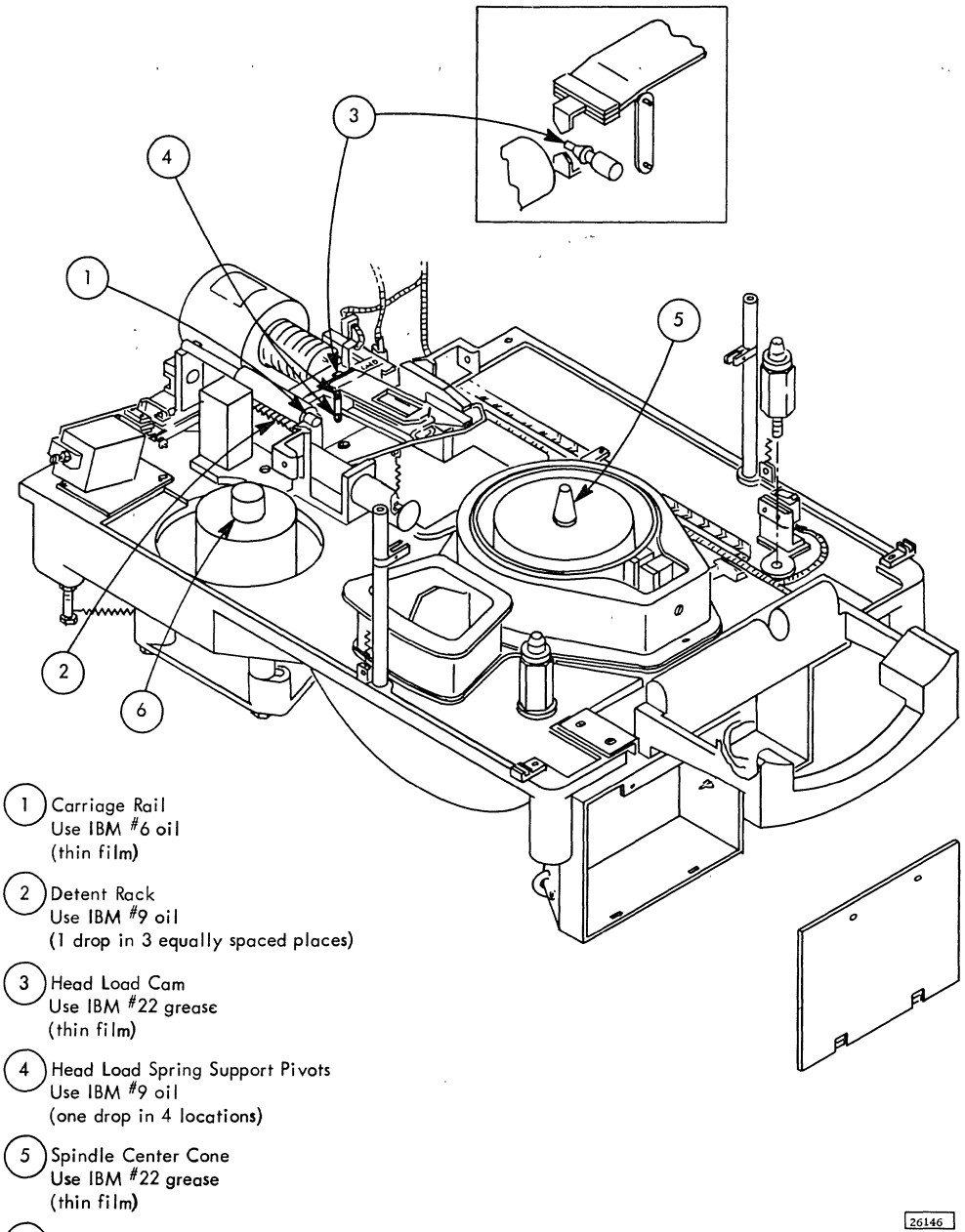
CODE U	CODE R	LOCATION OPERATION	*FREQ	OPERATION
3		Read/Write Heads	4	Clean; Inspect: Clean and inspect read/write heads for scratches and build up of oxide. See Section 3.3.2. Inspect head leads for damage.
		Carriage rail		Clean; Lubricate: Clean carriage rail with lint-free tissue and 91% Isopropyl alcohol. Apply a thin film of IBM #6 oil. Remove excess with lint-free tissue.
		Preload Bearing		Clean: Clean outer race of the Preload Bearing by holding a dry lint-free tissue against it while moving the carriage back and forth.
		Detent Rack		Clean; Lubricate: Clean detent Rack with IBM Brush (P/N 1018992). Place one drop of IBM #9 Oil in three equally-spaced places on the rack. Access the carriage from track 000 to 199 and back three or four times. Wipe excess oil from detent rack.
		Spindle Assembly (Magnetic Chuck)		Clean: Clean each pole piece of the Magnetic Chuck with lint-free tissue dampened with 91% Isopropyl Alcohol.
		Air Filter Electronics Duct		Replace Filter. Disconnect head plug leads from heads and loosen binding head screw on top of electronics gate. Swing gate door downward and remove air filter from left side of gate.
5		Head Load Cam	12	Lubricate: Apply a light film of IBM #22 grease on wear points of Head Load Cam surface.
		Head Load Spring Support Pivots		Lubricate: Apply one drop of IBM ±9 oil at four points of Head Load Spring Support Pivots.
		Spindle Center Cone		Lubricate: Apply a light film of IBM #22 grease on cone surface. Wipe off any excess grease.
		Drive Magnet and Voice Coil Motor Flux Gap		Inspect; Clean if necessary: Remove actuator motor (Drive Magnet) and inspect for contamination; especially for metal particles. If cleaning is necessary, place a piece of masking tape on a paddle with adhesive side exposed, and wipe each side of flux gap. Clean the voice coil with dry lint-free tissue.
		Base Plate Casting and Covers		Inspect; Clean: Inspect for cleanliness and loose parts. Clean as necessary.
		Air Filter Plenum Chamber		Test; Replace if necessary: Test plenum chamber air flow as outlined in Section 4.3.1. Replace air filter if necessary.
		Drive Belt Tension		Check; Adjust Loosen three motor mounting screws and allow the belt tension spring to position the motor to obtain the required belt tension. Tighten the screws progressively to prevent changing the position of the plate.
		**Drive Motor		Lubricate: Apply IBM #6 oil to fill oil cups on each end of motor shaft.
		Read/write heads		Check: Check read/write head alignment using CE disk Cartridge track 100 according to procedures of Section 4.17.1
		Sector Pulse Timing		Check: Check sector pulse timing using CE disk Cartridge track 095 according to procedures of Section 4.20.1

* The preventive maintenance Frequency is determined by machine usage rates computed at 176 hrs-per-month on a single shift basis

** Lubrication is to be accomplished on 50-cycle, 208/220-volt motors only.

Figure 3-1. Preventive Maintenance Schedule

26145



(1) Carriage Rail
Use IBM #6 oil
(thin film)

(2) Detent Rack
Use IBM #9 oil
(1 drop in 3 equally spaced places)

(3) Head Load Cam
Use IBM #22 grease
(thin film)

(4) Head Load Spring Support Pivots
Use IBM #9 oil
(one drop in 4 locations)

(5) Spindle Center Cone
Use IBM #22 grease
(thin film)

(6) 50 CPS Drive Motor
Fill cups on each end of shaft with IBM #6 oil
(Applicable for 50 cps, 220 volt drive motors only)

Figure 3-2. Lubrication Chart

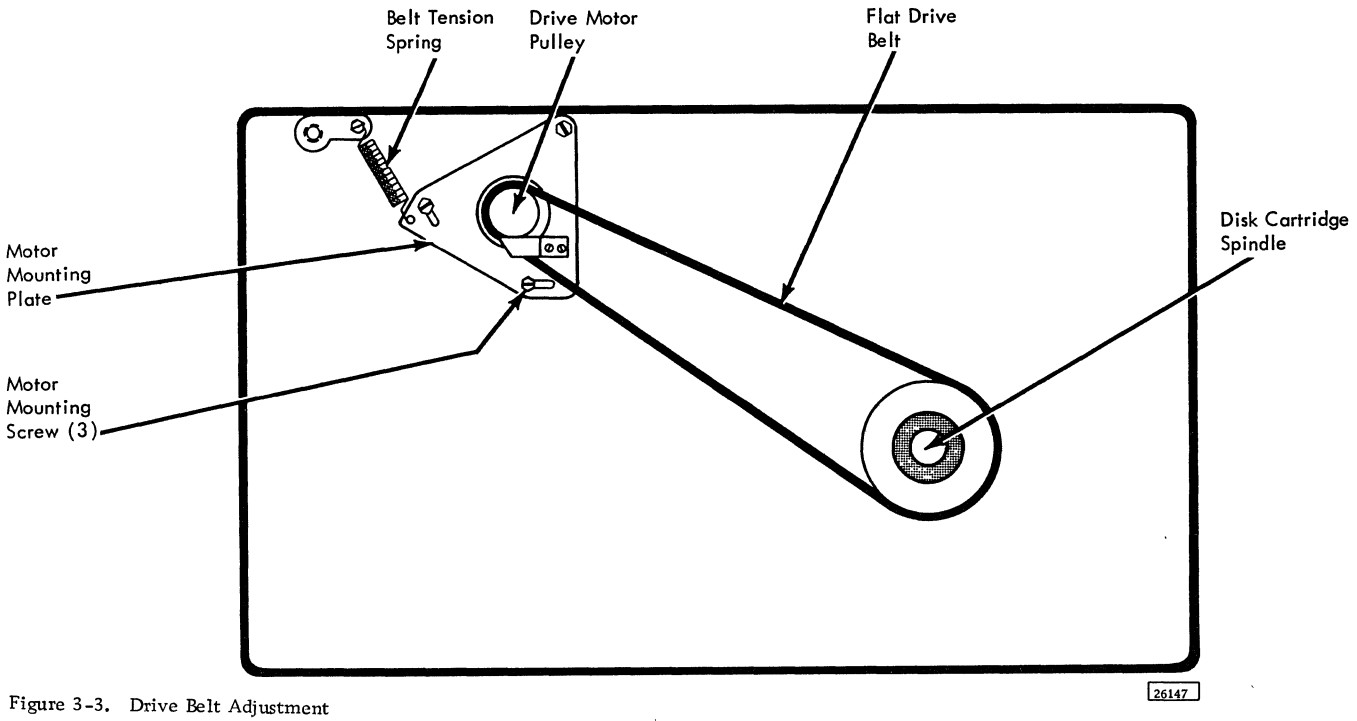


Figure 3-3. Drive Belt Adjustment

3.2.3 Drive Belt Tension Adjustment

Drive belt tension is to be adjusted according to instructions contained in Figure 3-1. The location of adjusting screws is contained in Figure 3-3.

3.3 HEAD AND DISK CARTRIDGE SCRATCH DESCRIPTION

3.3.1 Particle Damage to Disk

Head and disk damage can be caused by a small particle of foreign matter being deposited onto the surface of a disk. The gliding shoe of the head "flies" on an air bearing of 125 to 150 microinches while the disk is rotating.

When a particle is carried into the gap between the head and disk, it may be embedded into the surface of the disk. The damage which results from this and subsequent passes of the head over the embedded particle depends on the material and size of the particle.

Harder materials, such as aluminum oxide, may embed in the disk surface. A comet-trail scratch on the disk will mark the path of some particles.

3.3.2 Particle Damage to Head (Figure 3-4)

A large, hard particle embedded in the disk surface may cut a groove in the face of the shoe on the read/write head. The disk data tracks are 0.010 inch apart and a head being addressed to different tracks in the area of the embedded particle will soon be etched with a succession of 0.010 inch grooves or scratches across its face. Eventually, this particle could be dislodged or be pounded below the flight height (of this head) but not necessarily below that of a head on another machine.

When the surface of a head contacts a particle, a burr may be formed on the head, or the particle may be partially embedded in the head epoxy. If this protrusion on the gliding shoe is greater than the flight height, it will scratch the disk surface.

3.3.3 Non-Particle Damage

Damage to both head and disk surfaces can occur as a result of head-to-disk interference. This can be generally covered by considering that imperfections, on the surface of either head or disk, or any imperfection in shoe curvature that will interfere with proper head "flight", will result in interference.

Typical examples of surface imperfection would be fingerprints or other stains on the surface of a head or disk, residue resulting from misuse of Isopropyl Alcohol, lint, and dust from a contaminated atmosphere.

Presence of fingerprints, films, or stains on a head or disk surface means a deposit of oils and salts which, in most cases, will cause deposits to build up to a height greater than the flight height of the head. This condition can result in head-to-disk interference.

A continuous accumulation of foreign material on the head surfaces may result in generating read/write errors if scheduled maintenance activity is not followed.

3.3.4 Disk Cartridge and Read/Write Head Damage

Scratches on Disk Surfaces

Some types of scratches on disk surfaces are practically harmless while other types can result in damage to equipment. One type of harmful scratch is a typical comet trail where the head of the comet is an embedded particle protruding out of the surface.

Some types of scratches indicate other problems. Scratches which are regularly spaced 0.010 inch apart indicate a head had been used on that surface with a protrusion on its shoe face, or an embedded particle in the head pole epoxy.

A Series of Scratches or Grooves Across Head (Figure 3-4)

If a head has a series of 0.010 inch spaced grooves across the face of the shoe, it has been flown on a disk surface with an embedded particle which may or may not still be present. The presence of these grooves does not necessarily mean a ruined head. Heads become scratched during normal use but a damaged head will not read data properly, or it will fly with an audible tingling.

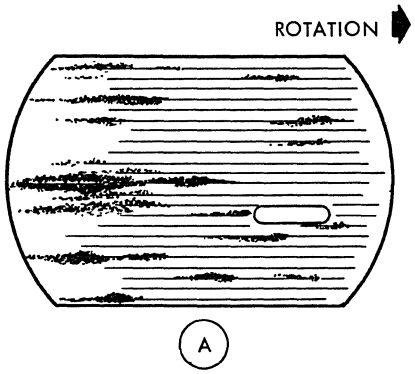
Oxide Deposit on Heads

The distinctive color of the reddish brown oxide makes it fairly easy to detect. Its presence may mean that oxide is being scraped off a disk surface by head to disk interference. Heads should be cleaned using preventive maintenance procedures.

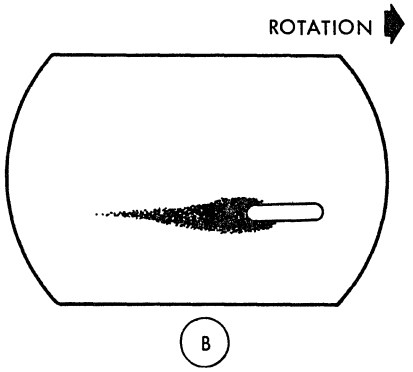
Audible Tingling from Head and Disk Interference

An audible tingling or scratching sound is an indication of head to disk interference. This can be an initial symptom and may not continue if the particle is dislodged or is smashed flat.

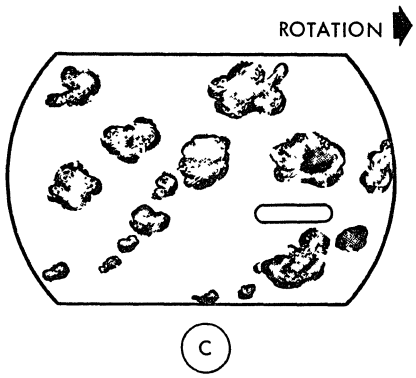
Examine the heads and disk surface for scratches and comet trails. The approximate radial position of the embedded particle can be determined by noting the track positions of the carriage where the tingling occurred. The head, cartridge, and spindle area should be thoroughly cleaned using scheduled maintenance procedures.



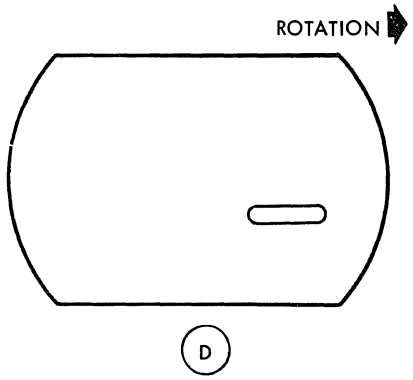
Scratch and oxide build-up due to scratches. Replace head-arm assembly.



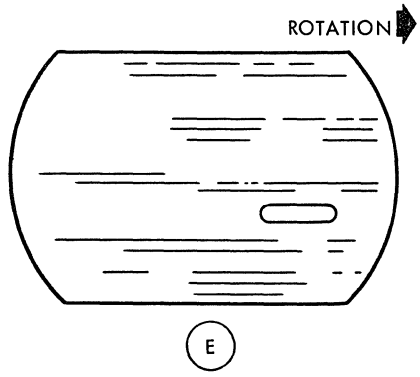
Oxide has accumulated in the pole tip area. Replace head-arm assembly.



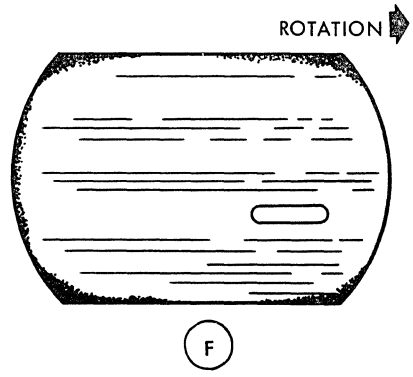
Alcohol Residue. Clean gliding surface with 91% isopropyl alcohol. However never allow alcohol to dry in small pools such that residue areas are formed. Remove alcohol, using lint-free tissue and a gentle wiping motion.



Finger prints and other oil like stains. These form an excellent means by which oxide may be transferred to the gliding surface. Complete removal of this contaminate is mandatory prior to resuming file operation.



Slight scratches without oxide build-up. Head-arm assembly may be used.



Slight oxide build-up. Clean with 91% isopropyl alcohol. Head-arm assembly may be used.

26148

Figure 3-4. Inspection of Read/Write Heads

4.0 INDEX OF SERVICE CHECKS, ADJUSTMENTS AND REMOVALS

Component	Service Checks	Cleaning	Adjustment	Removal/ Replacement
Actuator Assembly	Figure 3-1	Figure 3-1	Section 4.5.2	Section 4.5.1
Blower Assembly				Section 4.4.1
Blower Motor				Section 4.4.4
Blower Scroll				Section 4.4.3
Blower Wheel				Section 4.4.2
Carriage Preload Bearing				Section 4.14.1
Carriage Rail	Figure 3-1	Figure 3-1		Section 4.13.1
Carriage Subassembly				Section 4.15.1
Cartridge Assembly	Section 4.2.1, 4.2.2			Section 4.2.3
Cartridge In Place Switch			Section 4.18.3	
Cartridge Receiver			Section 4.18.2	Section 4.18.1
Crash Stop, Front			Section 4.10.1	
Crash Stop, Rear			Section 4.10.2	
Data Separator			Section 4.21.1	
Detent Assembly			Section 4.7.2	Section 4.7.1
Detent Rack	Figure 3-1		Section 4.7.4	Section 4.7.3
Disk Runout	Section 4.2.3			
Drive Belt	Figure 3-1		Section 3.2.3	Section 4.1.1
Drive Coil				Section 4.6.2
Drive Magnet		Figure 3-1		Section 4.6.1
Drive Motor				Section 4.1.2
Head Arm Assembly			Section 4.17.1	Section 4.17.2
Head Load Assembly	Figure 3-1		Section 4.8.2	
Head Load Spring Assembly	Figure 3-1			Section 4.9.1
Head Load Solenoid				Section 4.8.1
Heads Loaded Switch			Section 4.8.3	Section 4.8.3
Home Switch			Section 4.11.2	Section 4.11.1

INDEX OF SERVICE CHECKS, ADJUSTMENTS AND REMOVALS (Continued)

Component	Service Checks	Cleaning	Adjustment	Removal/ Replacement
Interlock Handle			Section 4.19.1	Section 4.19.1
Plenum Air Filter	Figure 3-1 Section 4.3.1			Section 4.3.2
Plenum Cover				Section 4.3.2
Read/Write Heads	Figure 3-1 Section 4.16.1	Figure 3-1 Section 3.2.1	Section 4.17.1	Section 4.17.2
Sector Transducer			Section 4.20.1	Section 4.20.2
Spindle Assembly	Figure 3-1			Section 4.1.3
Tachometer Assembly				Section 4.12.3
Tachometer Extension Rod			Section 4.12.2	Section 4.12.1

4.1 DRIVE MOTOR AND DRIVE BELT

4.1.1 Drive Belt Removal and Replacement

1. Loosen three hex-head mounting screws securing motor mounting plate to base plate.
2. Push drive motor mounting plate horizontally until drive belt slips off the pulleys.
3. Replace drive belt by reversing Steps 1 and 2.
4. Adjust the drive belt tension by following procedures of Section 3.2.3.

4.1.2 Drive Motor Removal and Replacement

1. Disconnect leads from terminal strip in ac power box.
2. Remove drive belt. See Section 4.1.1.
3. Remove four socket-head screws securing drive motor to motor mounting plate and remove drive motor.
4. Replace drive motor by reversing steps 1, 2, and 3. Adjust drive belt tension, Section 3.2.3.

4.1.3 Spindle Assembly Removal and Replacement

1. Remove drive belt. See Section 4.1.1.
2. Remove three socket-head mounting screws securing spindle housing to base plate (Figure 4-1). Access to mounting screws is provided through two holes (180° apart) located in bottom of outer pole piece of magnetic chuck assembly.
3. Lift the spindle vertically out of its locating bore.

WARNING: A close fit exists between the spindle housing and base plate. Do not pry the spindle off of the base-plate since the accurate location of the spindle can be destroyed if this is done.

4. Replace spindle assembly by reversing Steps 1, 2, and 3.

WARNING: Tighten the three mounting screws evenly or spindle alignment will be destroyed.

5. Adjust head-arm assemblies by alignment with track 100 on CE disk cartridge. See Section 4.17.1.

4.2 CARTRIDGE ASSEMBLY

4.2.1 Cartridge Service Check

Scratches on heads and/or disk data surface are related as described in Section 3.3. The following symptoms should be investigated to determine the cause of read/write problems:

1. Check for scratches on disk surfaces. See section 3.3.4 and Figure 3-4.
2. Check for a series of scratches or grooves across head. See section 3.3.4 and Figure 3-4.
3. Check for oxide deposited on heads. See Section 3.3.4 and Figure 3-4.
4. Check for audible tinging resulting from head and disk interference. See Section 3.3.4.

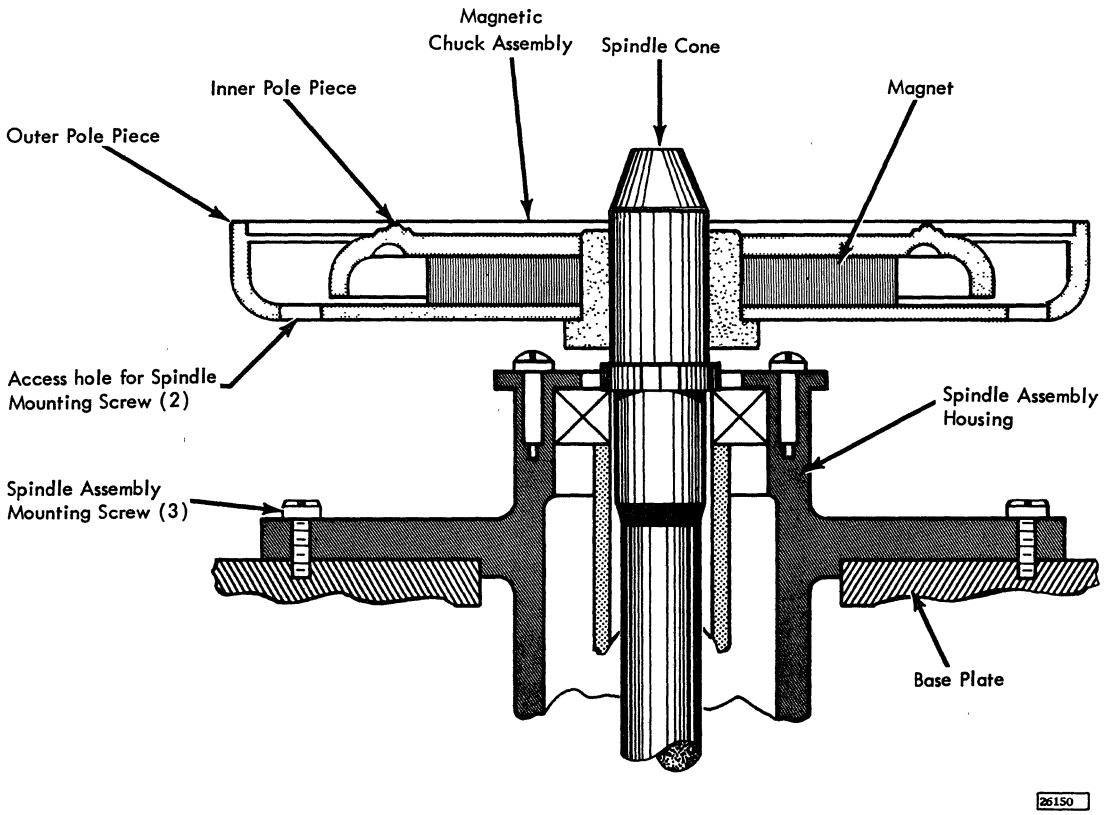


Figure 4-1. Magnetic Check and Spindle Assembly

4.2.2 Visual Inspection

Examine the disk surfaces for scratches and comet trails. The approximate radial position of the embedded particle can be determined by noting the track positions of the carriage where the tinging occurred. The head and the shroud area should be thoroughly cleaned using scheduled maintenance procedures. Also, the disk should be cleaned using the Branch Office disk cleaning fixture. (Cleaning of the disk is accomplished for remedial purposes, and is not scheduled as preventive maintenance.) Exercise care to prevent introducing foreign particles into the cartridge while inspecting the disk surfaces.

4.2.3 Disk Height and Run Out Check

The disk height and run out check is performed to determine if the amount of warpage in a disk exceeds allowable limits. The Disk Run Out Gage (P/N 2200050) is used to accomplish this check. This gage (Figure 2-2) is mounted on the base plate adjacent to the head arm assemblies, so that the disk can be manually rotated between the gap established by adjustable lips of the gage. A knurled adjusting screw on the gage permits adjusting the gap size to determine runout. Procedure for accomplishing a check for runout is as follows:

1. Remove power from the machine.
2. Remove cartridge from machine.
3. Remove top cover.
4. Remove the disk guide (Figure 6-1).
5. Remove the air deflector.
6. Remove the door opener along with its mounting bracket.

WARNING: Avoid dropping screws or spacers into the plenum through the cored hole in the casting. Loose items in this area can cause damage to the machine.

7. Position the disk run out gage on the base plate, in the space previously occupied by the disk guide. Use the tapped hole closest to the spindle for mounting the gage.
8. Insert cartridge partially into the receiver. After pushing it two-thirds of the way, open the

door manually and continue inserting the cartridge carefully while observing that the disk slides properly between the two read/write heads and in the mouth of the gage.

9. After the cartridge is pushed to the foremost position and touches the two cartridge stops, lower the cartridge door upon the upper side of the gage-base, and carefully lower the cartridge by operating the handle.

WARNING: Avoid scratching the disk while revolving disk through gage. Any scratching of the disk will cause damage: Be particularly careful in the procedure that follows.

10. Turn the spindle pulley slowly by hand. Listen carefully to determine that disk does not touch on the gage lip. If any contact noise is heard, readjust the disk run out gage by turning the adjusting screw. The disk is in proper height and its runout is within permissible limits, if the spindle can be turned one revolution without disk surface touching gage lips.
11. After the checking procedure is completed, carefully remove the cartridge, then the disk runout gage. Replace the door opener bracket and air deflector first, then the disk guide, and the top cover last.

4.2.4 Disk Cartridge Replacement Conditions

Replacement of a disk cartridge is necessary when any of these conditions exist:

1. The cartridge has sustained mechanical damage.
2. A surface of the disk is scratched or gouged and is causing read/write errors.
3. An embedded particle or surface contamination is present on a disk surface and the particle cannot be dislodged by cleaning.

4.3 PLENUM AIR FILTER

4.3.1 Plenum Filter Air Flow Test

1. **Prepare** a test gage as follows:
   a. Fold an IBM card at column 40 and again at columns 20 and 60 so that card is four layers thick.
   b. Tear off and discard one layer.
   c. Use transparent tape to secure edges so that card will remain flat in folded position.
2. Verify that blower is operating and disk cartridge is removed.
3. Place test gage over that half of the air valve duct which is nearest the disk cartridge receiver handle. If test gage remains in this position, the plenum filter is clogged and must be replaced. If it blows off or will not remain where placed, the air flow is sufficient and the plenum filter does not require replacement.

4.3.2 Plenum Air Filter Removal and Replacement*

WARNING: When replacing plenum air filter, make certain that the foam rubber seal is between the air filter and baseplate. If this seal is not in its proper position, leaks can result which will allow foreign particles to be blown into the cartridge. Also clean the plenum cover and cartridge air duct with lint-free tissue dampened with 91% Isopropyl Alcohol.

1. Remove plenum cover by removing single mounting nut which also secures the filter.
2. The air filter can be dropped vertically downward.
3. Replace air filter by reversing Steps 1, and 2.

4.4 BLOWER ASSEMBLY

4.4.1 Blower Assembly Removal and Replacement*

1. Turn off all power to machine.
2. Disconnect blower motor leads from terminal strip located in ac box.
3. Remove four binding-head mounting screws securing blower motor mounting bracket to baseplate. The blower assembly must be moved forward 1/2 inch for duct to clear electronic gate.
4. The blower may now be lowered vertically away from baseplate.
5. Replace blower assembly by reversing Steps 1, 2, 3, and 4.

4.4.2 Blower Wheel Removal and Replacement

1. Remove face-plate at inlet to blower assembly which is secured by three screws.
2. Loosen set screw securing blower wheel to motor shaft and slide wheel out inlet to blower scroll.

*Alternate procedures are contained in Chapter 7 for machines with serial numbers 00001 through 00050.

3. Replace blower wheel by reversing steps 1 and 2.

4.4.3 Blower Scroll Removal and Replacement

1. Remove blower wheel (Refer to Section 4.4.2).
2. Remove four binding-head screws on inside of scroll securing blower scroll to blower motor mounting bracket.
3. Replace blower scroll by reversing steps 1 and 2.

4.4.4 Blower Motor Removal and Replacement*

1. Remove blower wheel (Refer to Section 4.4.2).
2. Remove blower scroll (Refer to Section 4.4.3).
3. Remove two binding-head screws, two clamps, and two nuts securing blower motor to blower motor mounting bracket.
4. Replace blower motor by reversing steps 1, 2, and 3.

4.5 ACTUATOR ASSEMBLY

4.5.1 Actuator Assembly Removal and Replacement (Figure 4-2)*

The entire carriage and mount of the actuator assembly may be removed as a unit as follows:

1. Shut off all power to the machine and remove cartridge.
2. Remove cartridge receiver (See Section 4.18.1).
3. Disconnect read/write head cables from receptacles and remove the clamp which secures the cable receptacles.
4. Unsolder home switch leads and mark each lead with a different colored grease pencil to facilitate identification.
5. Remove tachometer leads from terminal strip and note terminal from which each lead is removed. Unsolder leads from the voice coil and note terminal from which each lead is removed.
6. Remove retaining ring from pivot pin in head-load solenoid plunger and slide pivot pin out of plunger.
7. Disconnect the spring attached to the cartridge door opener and remove the air baffle mounted between actuator and shroud. Remove the disk guide located adjacent to the actuator assembly.
8. Remove the five slotted hex-head mounting screws which secure the actuator assembly to the baseplate.
9. Lift carriage drive assembly vertically off the two dowel pins in carriage mounting base along with the tachometer assembly which is attached to the actuator assembly.

CAUTION: Ensure that correct leads are matched to terminals on the tachometer assembly and voice coil after replacing the actuator. Reversal of these leads would cause uncontrolled carriage motion resulting in damage to equipment.

10. Replace actuator assembly by reversing steps 2 through 8. Check head load adjustment and readjust if necessary (See Section 4.8.2).

4.5.2 Access Adjustments

Four adjustments are accomplished in the access logic circuits to maintain carriage positioning. Figure 4-3 shows the location of potentiometers involved for these adjustments.

A static and dynamic balance adjustment of the tachometer is accomplished to ensure that smooth detent operation will occur for carriage travel in both directions.

An amplifier dead band adjustment is made to minimize carriage oscillations when the carriage is decelerated to arrive at a new track location.

A 10 milli-inch and 20 milli-inch integrator-set adjustment is made to calibrate the trip level for decelerating and stopping carriage motion within limits for a single step increment. A separate adjustment is made for each stepping mode.

A 10 millisecond single shot (Access Ready) adjustment provides for timing of the detent to correctly seat in the rack after carriage has been accessed to a new track location.

WARNING: Use Alignment Screwdriver (P/N 460811) to avoid shorting adjacent contacts to the Access Amplifier and Access Logic SLT cards.

Tachometer Static Balance Adjustment

1. Apply power to machine and statically balance the tachometer amplifier output voltage measured between pins F2B12 and F2D11 by adjusting the 2k-ohm Tachometer Balance potentiometer (Figure 4-3) located on the Access Amplifier card.

*Alternate procedures are contained in Chapter 7 for machines with serial numbers 00001 through 00050.

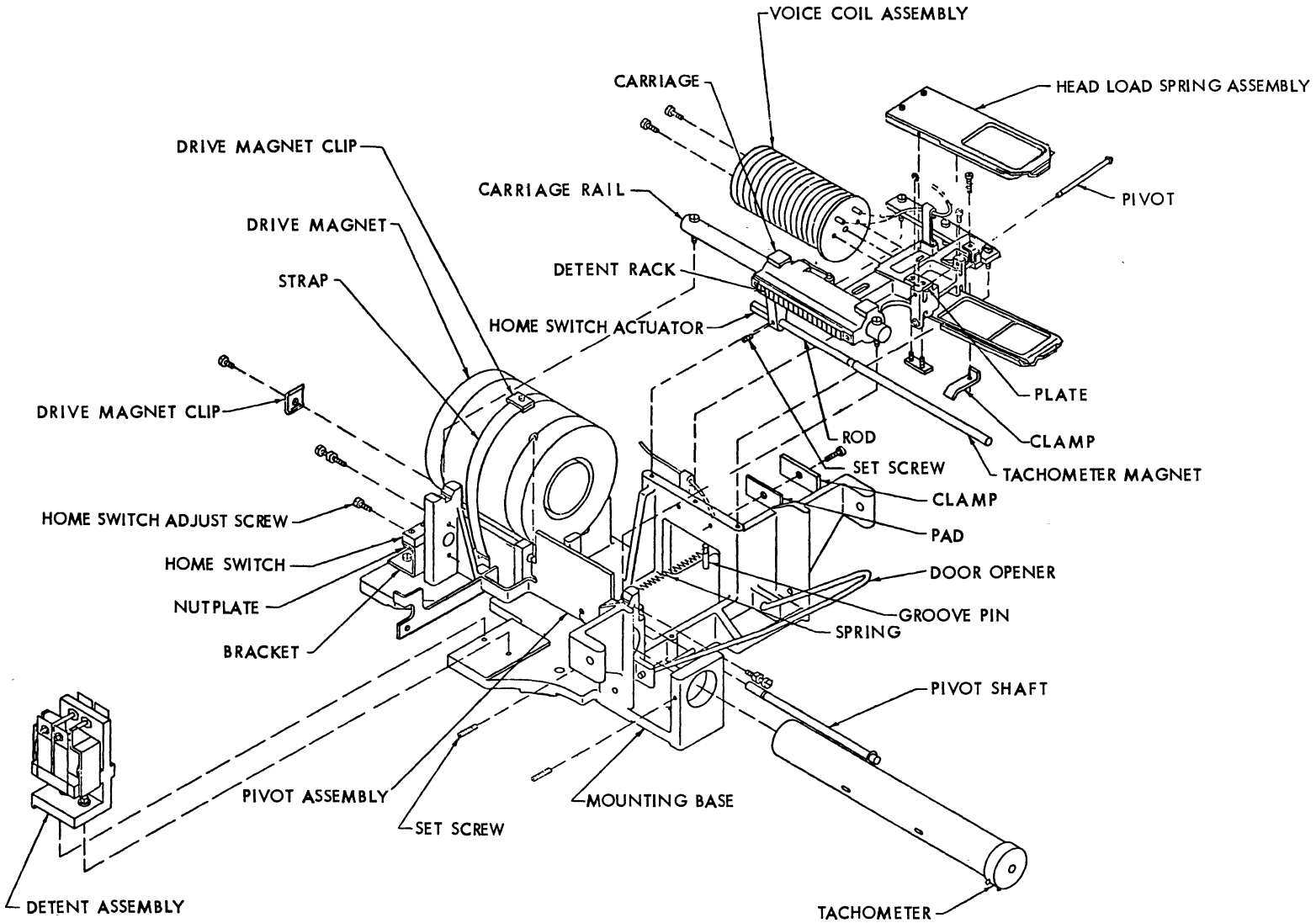


Figure 4-2. Actuator Assembly, Exploded View

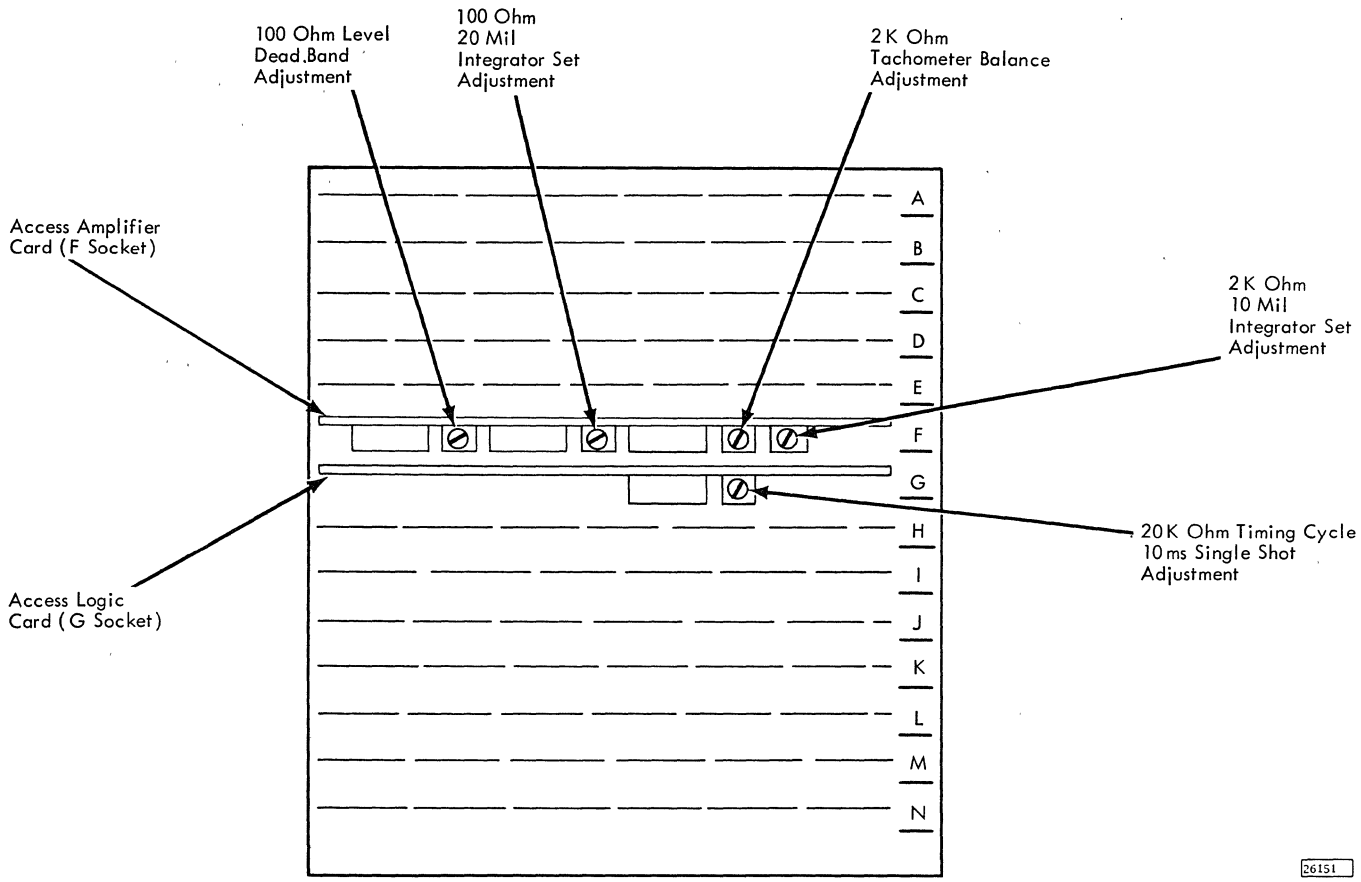


Figure 4-3. Access Adjustment, Potentiometer Locations

2. Adjust the potentiometer to obtain a zero voltage across pins F2B12 and F2D11 for a balanced condition.
3. Measure the voltage from F2B12 or F2D11 to ground under the same balanced conditions of step 2 above. This voltage should be within +0.65 vdc maximum and -0.85 vdc minimum.

Dead Band Adjustment

1. Monitor wiper voltage of the dead band potentiometer on pin F2D13.
2. Adjust the dead band in the power driver amplifier by using the 100-ohm level, Dead Band potentiometer (Figure 4-3) to narrow the width of the dead band. The voltage on F2D13 will become more positive as the dead band is narrowed, causing the actuator to oscillate.

NOTE: On some systems, the amplifier gain will be so high that the actuator will begin to oscillate at frequencies higher than 200 cycles per second. This condition may be detected audibly by a whine caused by the frequency generated by the voice-coil motor.

3. Narrow the dead band until the actuator begins to oscillate, and then widen the dead band (decrease voltage) until oscillations cease.
4. Continue to widen the dead band by an additional two full turns of the potentiometer after oscillations cease.

CAUTION: An audible "click" is heard when the 100-ohm level, Dead Band potentiometer is rotated to the extreme wiper-end position. The adjustment screw must be backed off two full turns whenever this point is reached. If the adjustment

screw is not backed off, or is rotated beyond this point at the high voltage end, damage could result to bridge resistors in the amplifier circuit.

NOTE: If the system does not oscillate, the dead band should be narrowed as much as will be allowed by the potentiometer. The narrowest dead band corresponds to the highest (most positive) voltage that can be measured at pin F2D13. Under no circumstances should the potentiometer setting be more than two full turns from the wiper-end containing the most positive voltage.

Coarse Timing Adjustment of Access Ready (10MS Single Shot)

1. Apply access drive pulses to access circuits by operating the CE Step Control switch.
2. Monitor the Access Ready signal on pin G2D04. This line drops from +L to -L (+3v to -3v) about 5 milliseconds after the access drive pulse is applied.
3. Adjust the duration of the -L level of Access Ready signal for 10 ±0.5 milliseconds using the 20K-ohm, Timing Cycle potentiometer (Figure 4-3) located on the access logic card. A fine timing adjustment must be made after the 20 and 10 milli-inch Integrator Trip Level adjustments have been accomplished.

20 Milli-inch Integrator Trip Level Adjustment

NOTE: When stepping the carriage in the CE control mode, the direction of step must be continuously controlled manually by the CE. Otherwise, the carriage would strike either front or rear crash stops. The direction of travel is controlled by the Direction Switch located on the CE Panel.

1. Set the actuator to take 20 milli-inch steps by appropriately setting the Step Mode switch on the CE panel.
2. Perform an initial setting of the accelerating drive pulse width by adjusting the 100-ohm, 20 Mil Integrator Set potentiometer (Figure 4-3) to obtain a value of +3.9 vdc when measured at pin F2B02.
3. Perform a fine adjustment of the 20 milli-inch accelerating drive pulse width as follows:
   a. Command the actuator to step continuously forward and backward in the 20 milli-inch mode by appropriately setting the Step Control switch on the CE Panel. Observe operation of the detent clapper. Proper operation of the actuator for this step mode occurs when the carriage moves from zero velocity at one track and arrives at zero velocity to the next track 20 milli-inches away. Under this condition, the detent mechanism will reposition the carriage only very slightly to achieve final track position accuracy. When this condition prevails, the detenting action is very smooth.

NOTE: Non-smooth detenting action can be determined by direct observation of the detent clapper. When operating properly, the detent clapper will move so smoothly and quickly that it will appear to be stationary.

   b. Readjust the 100-ohm, 20 Mil Integrator Set potentiometer by rotating in one direction until the detent clapper does not appear to be stationary, but displays erratic motions. Measure the dc voltage at pin F2B02 and record this high voltage limit. Next, turn the potentiometer in the opposite direction until the detent clapper motion is first smooth, and then once again erratic. Once more, measure the voltage at pin F2B02 and record this low voltage limit.
   c. Perform a final adjustment of the potentiometer to ensure that the voltage at pin F2B02 is 65% of the difference between the extremes of voltage limits producing erratic motion with the most positive value taken at 100%. When determining the extremes, the carriage should be allowed to travel in both the forward and reverse directions. The actuator is now properly adjusted for twenty milli-inch steps.

10 Milli-inch Integrator Trip Level Adjustment

1. Set the actuator to take 10 milli-inch steps by appropriately setting the Mode Switch on the CE Panel.
2. Perform an initial setting of the accelerating drive pulse width by adjusting the 2K-ohm, 10 Mil Integrator Set potentiometer (Figure 4-3) to obtain a value of +5.0 vdc when measured at pin F2B02.
3. Perform a fine adjustment of the 10 milli-inch accelerating drive pulse width as follows:
   a. Command the actuator to step continuously forward and backward in the 10 milli-inch mode by appropriately setting the Step Control switch on the CE Panel. Observe operation of the detent clapper. Proper operation

of the actuator for this step mode occurs when the carriage moves from zero velocity at one track and arrives at zero velocity to the next track 10 milli-inches away. Under this condition, the detent mechanism will reposition the carriage only very slightly to achieve final track position accuracy. When this condition prevails, the detenting action is very smooth.

NOTE: Non-smooth detenting action can be determined by direct observation of the detent clapper. When operating properly, the detent clapper will move so smoothly and quickly that it will appear to be stationary.

b. Readjust the 2K-ohm, 10 Mil Integrator Set potentiometer by rotating in one direction until the detent clapper does not appear to be stationary, but displays erratic motions. Measure the dc voltage at pin F2B02 and record this high voltage limit. Next, turn the potentiometer in the opposite direction until the detent clapper motion is first smooth, and then once again erratic. Once more, measure the voltage at pin F2B02 and record this low voltage limit.
c. Perform a final adjustment of the potentiometer to ensure that the voltage at pin F2B02 is 65% of the difference between the extremes of voltage limits producing erratic motion with the most positive value taken as 100%. When determining the extremes, the carraige should be allowed to travel in both the forward and reverse directions. The actuator is now properly adjusted for 10 milli-inch steps.

Fine Timing Adjustment of Access Ready (10MS Single Shot)

1. Apply access drive pulses to the machine by using the CE Step Control switch to step the carriage forward and backward in the 20 milli-inch step mode.
2. Adjust the 20K-ohm, Timing Cycle potentiometer (Figure 4-3) to provide a time of 14 ±0.1 milliseconds between the negative-going leading edge of the Access Drive pulse at pin G3B03 and the positive-going trailing edge of the Access Ready signal at pin G2D04.

Tachometer Dynamic Balance Adjustment

Dynamic balancing is necessary when the system cannot be adjusted for proper, smooth detent operation for carriage travel in both directions. The system should be dynamically balanced as follows:

1. Step the actuator continuously in the 10 milli-inch step mode and adjust the 2K-ohm, Tachometer Balance potentiometer until detent action is no longer smooth.
2. Stop the actuator and measure the balance voltage from pin F2B 12 to pin F2D11. Record this value.
3. Step the actuator once more, and turn the 2K-ohm, Tachometer Balance potentiometer in the other direction until the detent action first becomes smooth, and again becomes erratic.
4. Stop the actuator and again measure the balance voltage from pin F2B12 to F2D11. Record this value.
5. Compute the average value of the balance voltage and adjust the 2K-ohm Tachometer Balance potentiometer until this voltage value appears across the designated pins.
6. Recheck the 20 milli-inch integrator trip level setting by performing a fine adjustment for the 100 ohm, 20 Mil Integrator Set potentiometer contained in steps 3a, 3b, and 3c. Omit the initial voltage setting contained in steps 1 and 2.
7. Recheck the 10 milli-inch integrator trip level setting by performing a fine adjustment for the 2K-ohm, 10 Mil Integrator Set potentiometer described in steps 3a, 3b, and 3c. Omit the initial voltage setting described in steps 1 and 2.

4.6 DRIVE MAGNET AND COIL

4.6.1 Drive Magnet Removal and Replacement (Figure 4-2)*

1. Turn off all power to the machine.
2. Push the carriage forward as far as it will extend.
3. Remove screw and clip from top of the magnet which secures the strap clamp to magnet.
4. Remove the screw and clip from back of the magnet which secures magnet to cradle of actuator bracket.
5. Slide magnet horizontally back from bracket cradle.

*Alternate procedures are contained in Chapter 7 for machines with serial numbers 00001 through 00050.

6. Replace drive magnet by reversing steps 1 through 5. Ensure that magnet contacts front stop on actuator bracket before securing the installation with mounting screws.

4.6.2 Drive Coil Removal and Replacement

1. Turn off all ac and dc power.
2. Remove drive magnet (refer to section 4.6.1).
3. Unsolder voice coil leads and note terminal from which each lead is removed.
4. Remove three binding head mounting screws located inside the voice coil.
5. Slide coil horizontally, away from carriage, off dowel pin.

CAUTION: Ensure that correct leads are matched to terminals on the voice coil after replacement. Reversal of these leads would cause uncontrolled carriage motion resulting in damage to equipment.

6. Replace drive coil by reversing steps 2 through 4. Replace drive magnet (see Section 4.6.1).

4.7 DETENT ASSEMBLY AND DETENT RACK*

4.7.1 Detent Assembly Removal and Replacement

1. Disconnect detent coil leads from terminal strip. Mark the pin location of each lead prior to removal to facilitate identification.
2. Remove two nex-head mounting screws securing detent assembly to carriage mounting base.
3. Remove detent assembly by lifting it upward away from carriage assembly.
4. Replace detent assembly by reversing steps 1, 2, and 3. Insert mounting screws, but do not tighten at this time. Adjust detent assembly (refer to section 4.7.2).

4.7.2 Detent Assembly Adjustment (Figure 4-4)

WARNING: The only CE adjustment required is the fixed pawl-to-rack alignment which is established by controlling the air gap between clapper and pole piece of the energized detent. Do not, under any circumstances, loosen screws holding the springs, electromagnet, or pawls and pole pieces.

1. Energize one of the detents.
2. Push registration ledge of detent assembly against the corresponding edge of carriage mounting base (Figure 4-4).
3. Insert a 0.006-inch, non-magnetic shim in the gap between clapper and pole piece and slide detent assembly along registration ledge until energized detent pawl engages the rack.
4. Ensure that the 0.006-inch gap between clapper and pole piece is maintained while positioning the assembly to engage the rack. The shim should have a sliding-fit in the gap.
5. Repeat this procedure for the other detent by energizing its electro-magnet and maintaining the 0.006-inch gap between clapper and pole piece with pawl engaged in rack.
6. Tighten mounting screws to secure the detent assembly. Check the air-gap dimension between clapper and pole pieces of both detents to ensure that a 0.006 (±0.001) inch clearance is maintained.
7. Insert CE disk cartridge, and remove CPU signal cable from processor so that CE switches can be used to control accessing.

WARNING: The CE disk cartridge must be inserted before continuing with the procedure.

8. Set the CE Step Mode switch to 10 milli-inch steps. Using the CE Step Control switch, move carriage one track (0.010 inch). The other detent pawl should now be engaged with the rack.
9. Move carriage slightly to check for good contact between pawl and rack engagement.
10. Set the CE Step Mode switch to 20 milli-inch steps, and repeat steps 8 and 9 to check operation of the other detent.
11. Turn off all power to the machine.
12. Replace CPU signal cable on processor.

NOTE: The Read/Write head must be adjusted with a CE Cartridge installed after each adjustment of the detent assembly has been accomplished. (Refer to section 4.17.1.)

4.7.3 Detent Rack Removal and Replacement*

Removal

1. Remove detent assembly (refer to section 4.7.1).

*Alternate procedures are contained in Chapter 7 for machines with serial numbers 00001 through 00050.

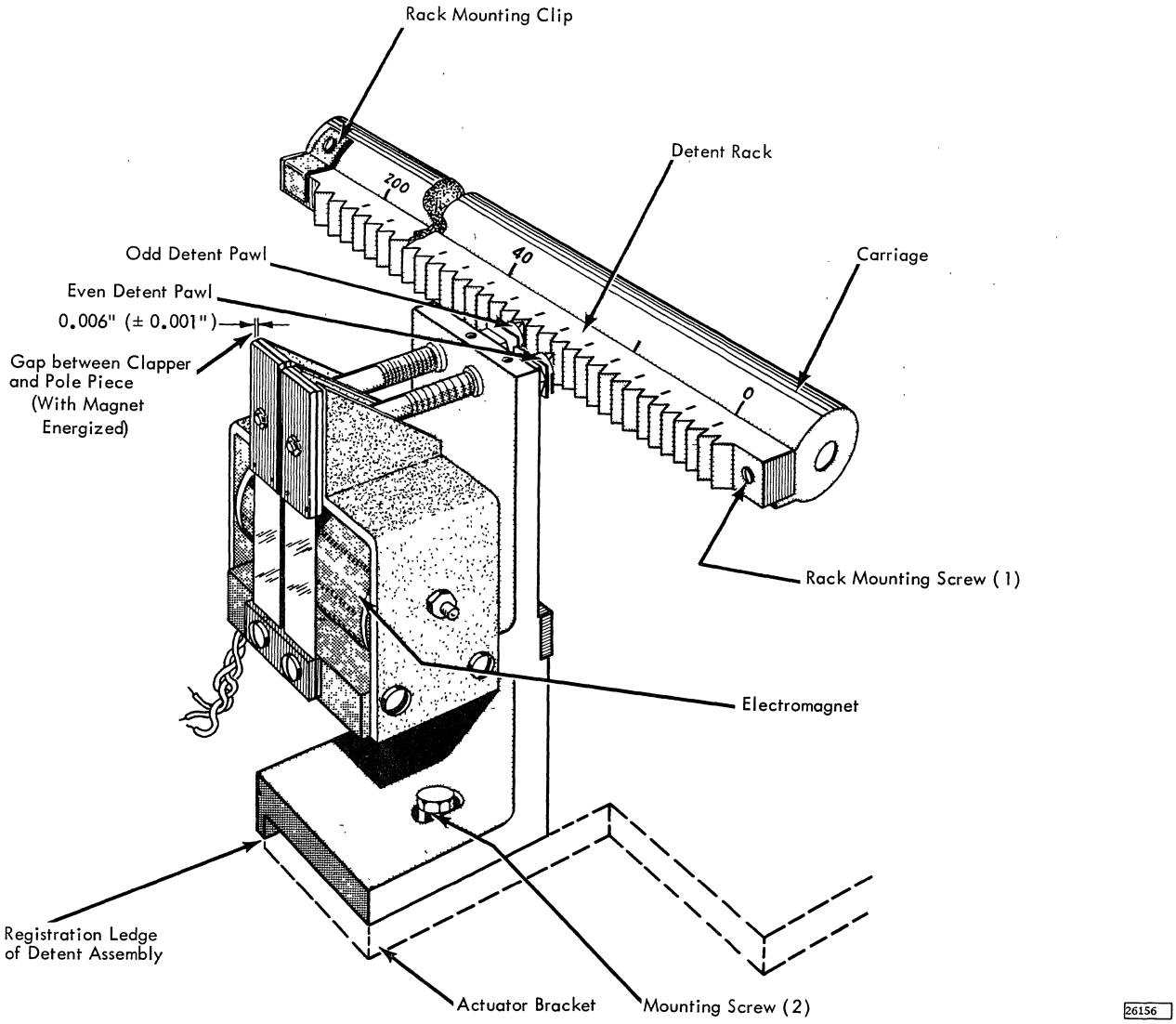


Figure 4-4. Detect Assembly, Adjustment

2. Remove the single binding-head mounting screw and clip that secure detent rack (Figure 4-5) to the carriage.
3. Lift detent rack to remove from carriage.

Replacement

1. Place detent rack in position shown in Figure 4-5. Position rack so that calibrated mark for track 100 on carriage is aligned with corresponding mark on rack. Press downward on rack to ensure contact between registration surfaces on detent rack and registration ledge on carriage (refer to section 4.7.4 for detail of adjustment).
2. Install single binding-head mounting screw and clip to secure the installation.
3. Replace detent assembly (refer to section 4.7.1).
4. Check detent adjustment by observing clapper spacing and detent alignment with the rack (refer to section 4.7.2).
5. Realign read/write heads (refer to section 4.17.1).
6. Adjust Crash Stops (refer to section 4.10.1 and 4.10.2).
7. Adjust Home Switch (refer to section 4.11.2).

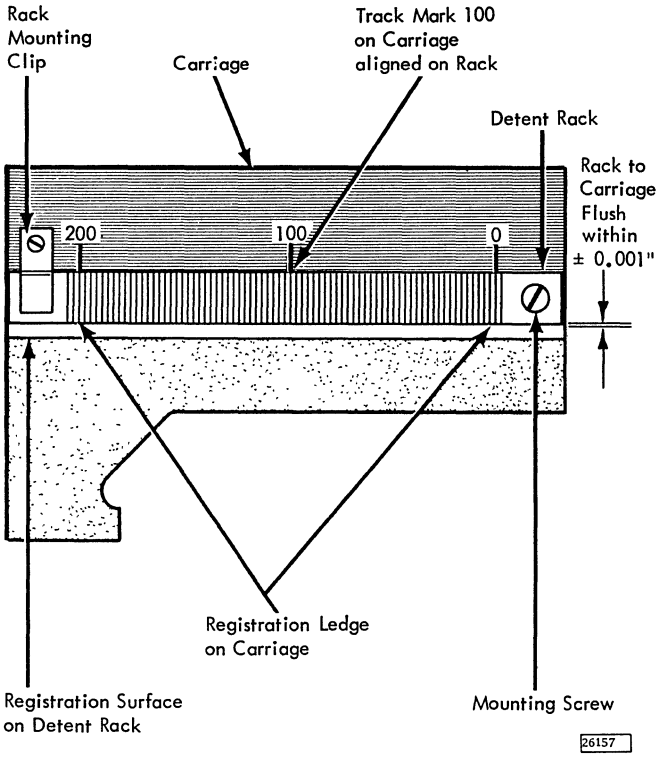


Figure 4-5. Detect Rack Removal and Replacement

4.7.4 Detent Rack Adjustment

NOTE: Adjustment of the detent rack is accomplished during replacement only. The rack should never be loosened or readjusted after it is initially installed on the carriage.

When a detent rack is replaced (section 4.7.3), the calibrated mark for track 100 on the carriage is aligned with the corresponding mark on the rack. The top registration surfaces of detent rack must be pressed to establish a flush contact with the registration ledge of carriage. The mounting screw and clip must be tightened to secure the detent rack alignment.

4.8 HEAD LOAD ASSEMBLY

4.8.1 Head Load Solenoid Removal and Replacement

1. Turn off all ac and dc power to machine.
2. Remove solenoid leads from terminal strip TB4 (pins 7 and 8).
3. Remove pivot pin from solenoid plunger.
4. Remove two binding head screws securing solenoid to mounting bracket.
5. Slide solenoid horizontally away from bracket to effect removal.
6. Replace the head load solenoid by reversing steps 1 through 5. Readjust head load assembly (section 4.8.2).

4.8.2 Head Load Assembly Adjustment (Figure 4-6)*

WARNING: Do not load heads when disk is not rotating in machine. When cartridge is out of machine, insert an IBM card between heads prior to loading. Failure to comply will result in damage to heads and/or disk.

1. Remove CPU signal cable from plug connection on machine.
2. Install a CE cartridge in machine.
3. Power up the machine and check for loading of heads.

NOTE: Read/Write heads should load after a 90-second delay. If heads fail to load, use the following procedure to accomplish head loading:

   a. Observe that solenoid plunger has bottomed out.
   b. Shut off power to machine.
   c. Loosen the two binding head screws that secure the head load solenoid to the mounting bracket.
   d. Use the solenoid adjust screw (0.031-inch per turn) to move the solenoid forward or backwards in the bracket. If solenoid plunger has bottomed out, move the solenoid backwards approximately 0.031 inch. If solenoid has not bottomed out, move solenoid forward approximately 0.031 inch.
   e. Tighten the two mounting screws to secure the adjustment.
4. Use masking tape to hold the heads loaded switch in the transferred position. Loosen the switch mounting screws and slide the switch backwards toward the solenoid as far as possible.

*Alternate procedures are contained in Chapter 7 for machines with serial numbers 00001 through 00050.

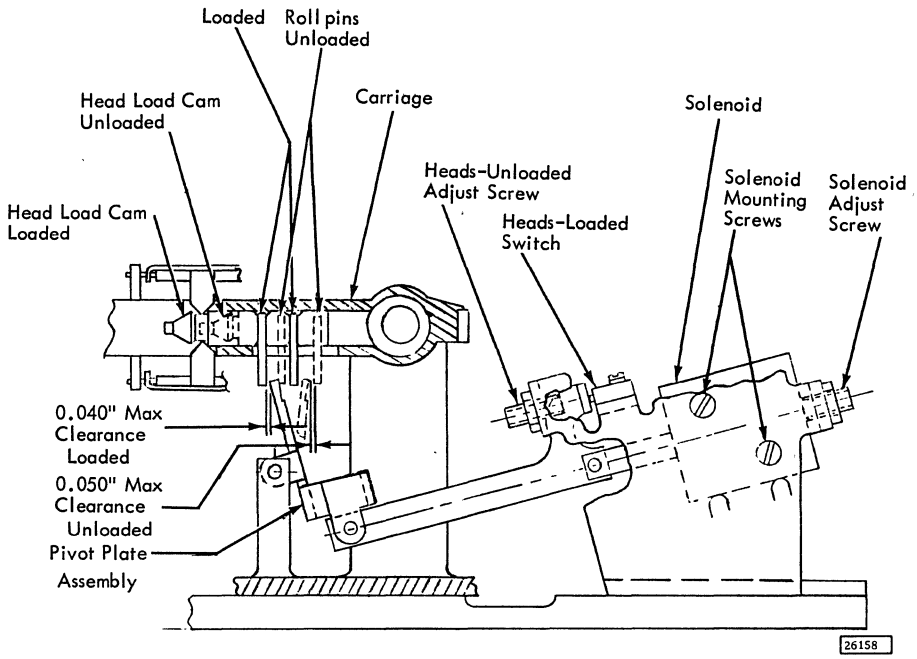


Figure 4-6. Head Load Assembly, Adjustment

WARNING: If the Heads Loaded switch is not held in transferred position, 48 vdc will be applied to solenoid coil resulting in damage to equipment.

5. With the carriage detented at track 000, loosen the two solenoid mounting screws and the solenoid adjusting screw. Slide the solenoid backward until the pivot plate contacts the head-loading roll pin in the head load cam. Continue to slide the solenoid back until the cam moves all the way into the cam followers. Tighten the solenoid mounting screws and position the solenoid adjusting screw against the back of the solenoid.
6. Back off the solenoid adjusting screw one turn, and tighten the lock nut. Loosen the solenoid mounting screws and slide the solenoid backward so that it will bear lightly against the adjusting screw.
7. Check clearance between the pivot plate and head loading roll pin. This clearance should be within 0.031 (±0.010) inch. Tighten the solenoid mounting screws after this clearance has been obtained.
8. Adjust heads loaded switch using the following procedure.
   a. Slide switch toward head load contact point against the head load actuator link and remove the masking tape.
   b. Place a 0.005 inch shim between switch button and link. Move switch until it bottoms out.
   c. Tighten mounting screws to secure switch in this position.

CAUTION: Feel the head loaded solenoid coil by hand to inspect for overheating. The solenoid coil is warm to the touch during normal operation when 24 vdc is applied. A defective Heads Loaded Switch adjustment will cause 48 vdc to be applied to the coil resulting in excessive heating. If the coil is too hot to grasp and hold, the heads loaded switch is not in proper adjustment.

9. Adjust the heads loaded switch if solenoid coil is excessively hot. (Refer to procedures of section 4.8.3.)
10. Remove power from the machine.
11. Adjust the heads-unloaded adjust screw so that when heads are unloaded, a clearance of 0.030 (±0.020) inch exists between the pivot plate and the heads unloaded roll on the head load cam. Tighten the locknut to secure this adjustment.

NOTE: Failure of the linear ball bearings or head load cam requires replacement of the carriage assembly.

4.8.3 Heads Loaded Switch, Removal, Replacement, and Adjustment

1. Remove all ac and dc power from the machine
2. Unsolder leads at heads loaded switch (Figure 4-6) and note terminal from which each lead is removed.
3. Remove two binding head screws from nut plate located underneath the switch.
4. Remove heads loaded switch.
5. Replace heads loaded switch by reversing steps 2, 3, and 4. The switch should be positioned as near as possible to the solenoid.
6. Power up machine and load heads. As soon as heads are loaded, transfer switch with a 0.005-inch shim. Slide switch and shim toward head load actuator link until switch bottoms out.
7. Tighten mounting screws.

4.9 HEAD LOAD SPRING ASSEMBLY*

4.9.1 Head Load Spring Assembly Removal and Replacement*

1. Remove the split retainer ring from one side of head load spring assembly pivot pin.
2. Remove pivot pin.
3. Remove spring assembly.

NOTE: The head load spring assembly is replaced as a complete unit and is not to be disassembled.

4. Replace the head load spring assembly by reversing steps 1 through 3.

4.10 CRASH STOPS

4.10.1 Front Crash Stop Adjustment

Use appropriate switches on the CE Panel to operate carriage in a forward direction to detent on track 202 against front crash stop (near spindle).

Adjust screw on right end of front crash stop and tighten locknut so that a 0.006 (±0.003) inch clearance exists between front crash stop and carriage.

Operate carriage first in reverse direction, and then forward, to check that the 0.006 (±0.003) inch clearance adjustment is maintained at the front crash stop when carriage is detented on track 202.

4.10.2 Rear Crash Stop Adjustment*

Use appropriate switches on the CE Panel to operate carriage in a reverse direction to detent on track 000 against rear crash stop (near drive magnet).

Adjust screw on left end of rear crash stop and tighten locknut so that a 0.003 (±0.001) inch clearance exists between rear crash stop and carriage.

Operate carriage, first in forward direction and then reverse, to check that the 0.003 (±0.001) inch clearance adjustment is maintained at the rear crash stop when carriage is detented on track 000.

4.11 HOME SWITCH*

4.11.1 Home Switch Removal and Replacement (Figure 4-2)

1. Remove all ac and dc power from machine.
2. Remove leads from Home Switch terminals.
3. Remove two binding head screws securing Switch to mounting bracket.
4. Replace Home Switch by reversing steps 2 and 3 and adjust switch according to Section 4.11.2.

4.11.2 Home Switch Adjustment

1. Use appropriate switches on the CE Panel to operate carriage in a reverse direction to detent on track 001.
2. Place a 0.007-inch feeler gage between the carriage actuator and home switch pushbutton, and adjust the home switch adjusting screw until the switch just transfers.
3. Check this adjustment with a 0.005-inch feeler gage to determine that home switch will not transfer.

4.12 TACHOMETER AND TACHOMETER EXTENSION ROD

4.12.1 Tachometer Extension Rod Removal and Replacement (Figure 4-2)*

The tachometer extension rod can be removed from the tachometer core by unscrewing the rod from the core assembly. Use extreme care when removing the extension rod because the core can be broken or scarred. Remove the rod as follows:

*Alternate procedures are contained in Chapter 7 for machines with serial numbers 00001 through 00050.

1. Unscrew and remove the home switch actuator which serves as a lock screw to retain the rod in the carriage bracket.
2. Remove the set screw which secures the rod in carriage bracket.
3. Detatch the rod by unscrewing it from the carriage bracket, and slide the rod away from the home switch and out of the tachometer coil and housing assembly.
4. Replace tachometer extension rod by reversing steps 1, 2, and 3.

4.12.2 Tachometer Extension Rod Adjustment*

The tachometer extension rod is to be adjusted visually by positioning the tachometer shield so that the groove on the rod is flush with the end of the carriage end of the tachometer shield when the carriage is detented at track 000. Perform the adjustment as follows:

NOTE: Do not disconnect the rod from carriage to make this adjustment.

1. Detent carriage to track 000.
2. Loosen the two set screws which secure the tachometer and shield to the carriage mounting base.
3. Slide the shield along the rod until the groove in the rod is flush with the end of the tachometer shield.
4. Tighten the two set screws to secure the adjustment.
5. Check the carriage for friction to ensure that binding does not prevail as a result of making the tachometer extension rod adjustment.

4.12.3 Tachometer Assembly Removal and Replacement (Figure 4-2)*

1. Remove disk cartridge from machine.
2. Remove cartridge receiver, shroud, and spindle from base plate.
3. Unsolder tachometer cable leads from terminals on tachometer, and mark each lead to facilitate identification.
4. Remove the tachometer extension rod (see section 4.12.1).

*Alternate procedures are contained in Chapter 7 for machines with serial numbers 00001 through 00050.

WARNING: Caution must be exercised in handling the tachometer core and extension rod. These assemblies can be damaged if dropped.

5. Remove the two set screws in the carriage mounting base which secure the tachometer shield.
6. Slide tachometer shield out of carriage mounting base and tachometer bracket.
7. Slide tachometer coil and housing assembly out of tachometer shield.

WARNING: Slide coil and housing assembly out the end of tachometer shield nearest the spindle. Do not bend tachometer electrical leads back and forth since they can break within the coil and housing assembly.

8. Replace the tachometer assembly by reversing steps 2 through 7, and adjust according to section 4.12.2.

4.13 CARRIAGE RAIL

4.13.1 Carriage Rail Removal and Replacement (Figure 4-2)*

1. Turn off all ac and dc power to the machine and remove top baseplate cover.
2. Remove two retaining screws, one each, located at front and rear of rail. (These screws retain the rail in V-grooves of the carriage mounting base.)
3. Insert 0.100-inch feeler gage shim between the carriage preload spring and carriage. Remove preload force on the rail, and slide the rail out of the carriage mounting base being careful to avoid misalignment.

WARNING: Misalignment in this step could damage the carriage bearings.

4. Replace carriage rail by reversing steps 2 and 3.

4.14 CARRIAGE PRELOAD BEARING ASSEMBLY

4.14.1 Carriage Preload Bearing Assembly Removal and Replacement

1. Remove all ac and dc power to the machine.
2. Remove drive magnet. (Refer to Section 4.6.1.)
3. Remove drive coil. (Refer to Section 4.6.2.)
4. Remove two binding head mounting screws which secure preload bearing spring to carriage and remove bearing assembly.

NOTE: When replacing bearing assembly in step 4, ensure that edge of preload bearing is fully engaged with registration surfaces before tightening the mounting screws.

5. Replace carriage preload bearing assembly by reversing steps 2 through 4.

4.15 CARRIAGE SUBASSEMBLY

4.15.1 Carriage Subassembly Removal and Replacement*

1. Remove all ac and dc power to machine.
2. Remove Drive Magnet. (Section 4.6.1.)
3. Loosen binding head screw securing head plug clamp to release head plug. Disconnect head plugs from head cables.
4. Remove tachometer extension rod from carriage (see section 4.12.1).
5. Unsolder voice coil leads and note terminal from which each lead is removed.
6. Remove three binding head screws which secure carriage outrigger slide to carriage. Remove slide.
7. Remove carriage rail (see section 4.13.1).
8. Lift carriage assembly vertically, away from carriage mounting base.

WARNING: Caution must be exercised to ensure that read/write heads do not strike anything during removal.

9. Replace carriage subassembly by reversing steps 2 through 7.
10. Adjust tachometer extension rod according to section 4.12.2.
11. Adjust head-arm assemblies according to section 4.17.1.
12. Perform the following adjustments if a new carriage subassembly has been installed:
    a. Check detent adjustment and readjust if necessary according to section 4.7.2.
    b. Adjust front and rear crash stops according to section 4.10.

*Alternate procedures are contained in Chapter 7 for machines with serial numbers 00001 through 00050.

c. Adjust home switch according to section 4.11.2.

4.16 READ/WRITE HEADS

4.16.1 Read/Write Head Service Check

The Service Check for read/write heads is a part of the preventive maintenance schedule described in Figure 3-1. Refer to Section 3.3 for a description of the causes of read/write head damage.

4.16.2 Read/Write Head Replacement

The inspected read/write head need not be replaced unless it is capable of damaging disk surfaces or causing errors.

Disk damage by a head can usually be detected by:

1. Persistent oxide collection on the suspected head after cleaning.
2. Helical scratches and 0.010 inch spaced radial scratches on that disk surface.
3. Audible pinging noises.

If any of the above symptoms occur, the suspected head should be replaced.

NOTE: Clean the disk using the disk cleaning fixture and visually inspect the disk surface to be certain no "comet trails" with embedded particles are present to damage the new head. See Section 3.3.1.

After head replacement and proper disk cleaning, the new head should be checked for audible tinging after the new head is loaded and is addressed onto the disk cartridge.

4.16.3 Read/Write Head to Base Plate Resistance Check

The resistance from read/write head to baseplate should be checked in the event of read errors which cannot be traced to any other source.

Follow this procedure:

1. With cartridge out of the machine, load head on a loading pad (IBM card).
2. Check electrical resistance from read/write head to carriage. This resistance should not exceed 5 ohms. If this resistance exceeds 5 ohms, replace read/write head-arm assembly and/or head load spring assembly.
3. Check resistance from carriage to baseplate. If this resistance exceeds 5 ohms, check the ground lead in the drive coil cable, which grounds carriage to baseplate, for breakage or loose connections.

4.17 HEAD-ARM ASSEMBLY

4.17.1 Head-Arm Assembly Adjustment*

Both sides of the CE Cartridge contain accurately recorded master tracks at track position 100. The width of this track (0.005 inch) is the same as a data track after tunnel erasure. The track is written with a clock pattern of all zeros at a frequency of 720 KC. The track is read by the tunnel erasure element of the read/write head for purposes of adjustment and both heads must be adjusted to obtain equal amplitudes for the envelopes developed by the signal.

NOTE: The Head Alignment Oscilloscope Adapter (P/N 2200052) is used to connect the erase winding into the preamplifier of the read circuit. Output for scoping is from Pin D3B07. Location of head clamping screws and adjustment screws is shown in Figure 4-7. Oscilloscope signal-pattern displays are shown in Figure 4-8.

The CE track is written with a slight eccentricity so that it will sweep slightly below one leg of the tunnel erase pole tip during one-half revolution of the disk, and then slightly above the other leg of the pole tip during the other one-half revolution. With proper adjustment of the heads, the signal will appear on the scope as shown in View B, Figure 4-8.

If a slight misalignment exists, the track will sweep more under one leg than the other, and the envelopes generated will be at different amplitudes as shown in View A, Figure 4-8.

If a bad misalignment exists (for example: 0.004 inch), one leg only will see the track, and a large signal, of more or less constant amplitude, will appear on the scope.

*Alternate procedures are contained in Chapter 7 for machines with serial numbers 00001 through 00050.

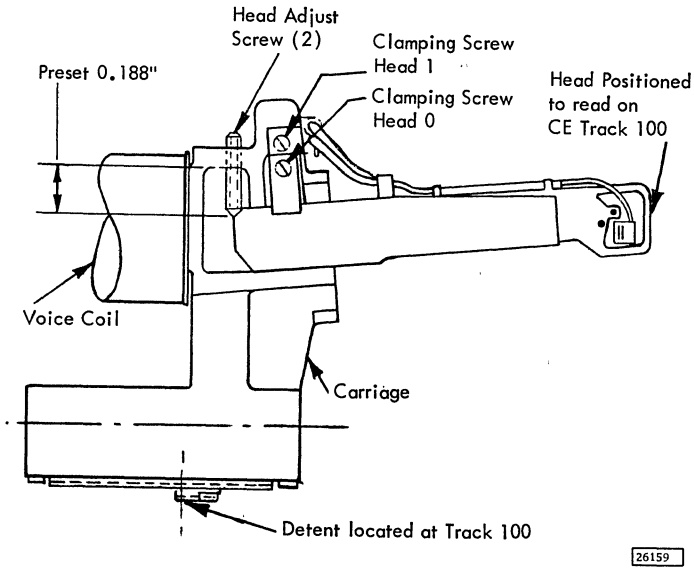


Figure 4-7. Head-Arm Assembly Adjustment

If misalignment is total (for example: 0.100 inch), no signal, only noise will appear on the scope.

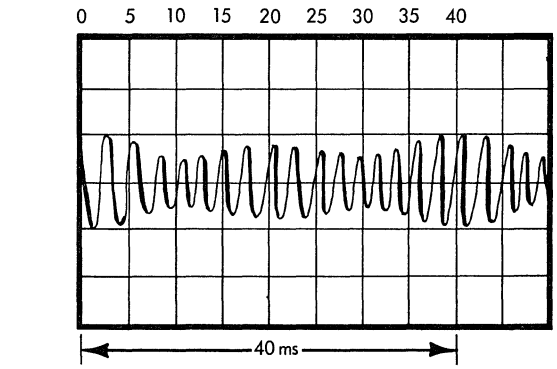
Procedures for adjustment of head-arm assembly are to be accomplished as follows:

1. Torque both head clamping screws to 3.5 (±1.0) pound-inches.
2. Back off the head adjusting screws and push each head-arm assembly back toward the voice coil until the head load spring just clears the potted capsule on the head. A dental mirror is required to observe the lower head.
3. Install the CE cartridge and apply power to the machine to load heads. Use the CE switches to access the carriage to track 100, and ensure that the even detent is energized at this track location.
4. Allow the machine and cartridge to operate continuously for 15 minutes to ensure that temperature stabilization has taken place before adjusting heads.
5. Scope from Pin D3B07. Set time base to display 5 ms/cm (one revolution of the disk is 40 ms.) Synchronize the oscilloscope on Negative Reference, Pin K2B04.
6. Insert the Head Alignment Oscilloscope Adapter (P/N 2200052) between the head cable plug and socket for Head 0. Select Head 0 with the CE Head Select switch.
7. Slowly advance the head adjusting screw while observing the scope pattern. The scope will first show noise only, then the pattern of View A, Figure 4-8 will appear. When the head is properly aligned, the pattern of View B, Figure 4-8 will be present and the lobes will be equal in amplitude.

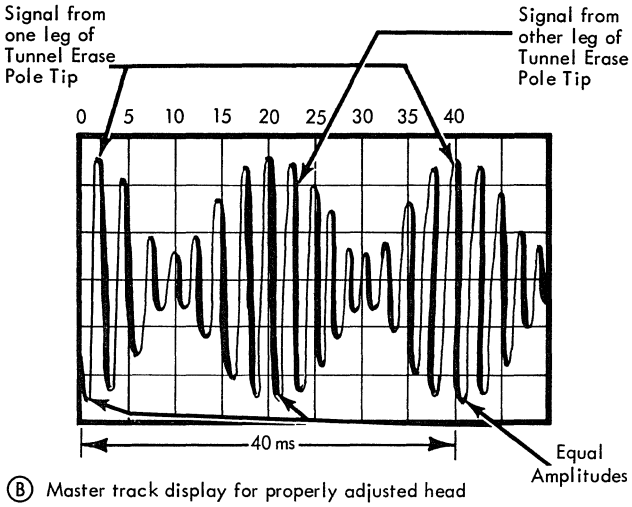
NOTE: If the head is moved forward, too far toward the spindle, it will be necessary to shut down the machine, remove the CE cartridge, and push the arm backwards toward the voice coil as described in step 2, then repeat step 7. When the head-arm assembly is correctly positioned, the lip of the head load spring will bear on the dimple of the arm assembly spring. The head load spring will not be in contact with the potted capsule which encases the read/write coils. It will be necessary to shift the detent rack slightly if correct adjustment cannot be made using step 7.

8. Back off the head adjusting screw one-half turn when adjustment has been completed. Observe the scope display pattern to ensure that the head alignment is not affected.
9. Use the CE switch to select Head 1, and repeat steps 2 through 8.

NOTE: If the detent rack was moved to accomplish the adjustment of head-arm assemblies, it will be



Ⓐ Initial appearance of master track 100



Ⓑ Master track display for properly adjusted head

26126

Figure 4-8. Signal Patterns for Head Alignment Adjustment

necessary to readjust the crash stops (section 4.10), home switch (section 4.11.2), and tachometer extension rod (section 4.12.2).

4.17.2 Head-Arm Assembly Removal and Replacement

1. Loosen binding head screw in head plug clamp sufficiently to remove head plug. Remove head plug from cable leading to electronics gate.
2. Remove head leads from head lead clip located near plastic outrigger slide on carriage.
3. Loosen head clamp but do not remove head at this time.

WARNING: Caution must be exercised when handling head-arm assemblies to prevent damage from rough handling or contamination from contact with solid surfaces.

4. Place fingers on the arm only. Do not grasp the flex-gimble springs or head assembly. Slide head horizontally toward spindle until head can be lifted out.
5. Replace head by reversing steps 1 through 4. Readjust head arm assembly with CE cartridge at track 100 according to Section 4.17.1.

4.18 CARTRIDGE RECEIVER*

4.18.1 Cartridge Receiver Removal and Replacement

1. Remove all ac and dc power from the machine.
2. Remove tension spring that attaches to cartridge receiver and interlock assembly.
3. Remove the two tension springs located at the ends of cartridge load rods.
4. Position cartridge receiver handle down, and remove cotter pins that secure cartridge load rods to side guides. Slip the cartridge load rods free.
5. Remove the two socket-head shoulder screws at receiver pivots.

WARNING: Exercise care in lifting the cartridge receiver from machine to avoid striking the detent assembly and disrupting the detent adjustment.

6. Lift the cartridge receiver from machine.
7. Replace the cartridge receiver by reversing steps 2 through 6.
8. Check the cartridge receiver adjustments described in section 4.18.1. Readjust only if absolutely necessary.

4.18.2 Cartridge Receiver Adjustment (Figure 4-9)*

NOTE: The cartridge receiver adjustment must be completed prior to attempting an adjustment of cartridge interlocks. Any cartridge serves as a gage for adjusting the side-to-side position of the cartridge receiver. After this adjustment is made, it should not be changed unless trouble

*Alternate procedures are contained in Chapter 7 for machines with serial numbers 00001 through 00050.

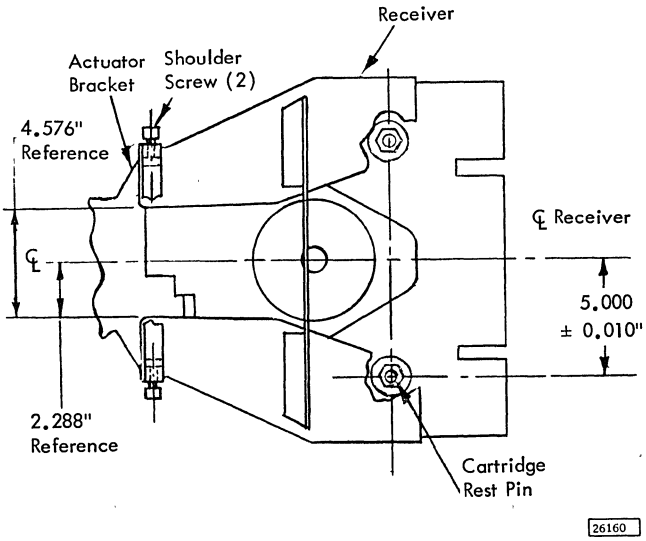


Figure 4-9. Cartridge Receiver Adjustment

is suspected. Adjustment is to be accomplished as follows:

1. Loosen both socket-head shoulder screws located on the pivots of the cartridge receiver so that receiver is free to move slightly.
2. With the front of the cartridge receiver located in its preferred position, tighten the two shoulder screws until they just contact surfaces of the cartridge receiver pivots. This will secure the adjustment.

4.18.3 Cartridge In Place Switch Adjustment

NOTE: The cartridge in place switch cannot be adjusted; however, its function may be checked by standing in front of machine while using the following procedure: (A quick check of the switch operation can be accomplished by step 4.)

1. Insert cartridge in receiver and observe the action of the cartridge in place switch as the receiver handle is raised.
2. Verify that switch transfers when cartridge is fully seated on its rest pins. Ensure that the cartridge is not touching the switch lever anywhere except on its operating end.
3. Use five IBM cards as shims between the shoulder of the closest rest pin and the bottom of the cartridge. Verify that the switch transfers before cartridge is fully seated on the rest pin.
4. With the cartridge receiver handle locked in place by the interlock latch to secure the cartridge in place, move the handle end of the cartridge up and down with moderate force to see if the transferred condition of the switch is affected. The switch must remain transferred.

4.19 INTERLOCKS

4.19.1 Handle and Interlock Adjustment (Figure 4-10)*

NOTE: The cartridge receiver adjustments (section 4.18.2) must be completed prior to attempting an adjustment of the cartridge interlocks. Two stationary posts located on the base plate prevent lowering of the cartridge before it is fully inserted into the receiver. The receiver interlock magnet must be removed to accomplish interlock adjustments for the Handle Stop Screw and latch screw clearance.

Handle Stop Screw Adjustment

The handle stop screw must be adjusted so that when a cartridge is in place, the handle risers will be parallel with the stationary guide posts within 0.30 (±0.015) inch. Adjustment of the handle stop screw is accomplished as follows:

1. Remove the interlock handle and bracket assembly.
   a. Remove the two flat-head screws which secure bracket to base plate.
   b. Remove wire connections at pins 3 and 4 from terminal block TB6. Mark each pin location to facilitate reassembly.
2. Install CE cartridge in machine.
3. Loosen handle stop screw locknut and adjust the handle stop screw so that handle risers are parallel with the stationary safety posts within 0.030 (±0.05) inch.
4. Tighten the locknut to secure the final adjustment made on the handle stop screw.

*Alternate procedures are contained in Chapter 7 for machines with serial numbers 00001 through 00050.

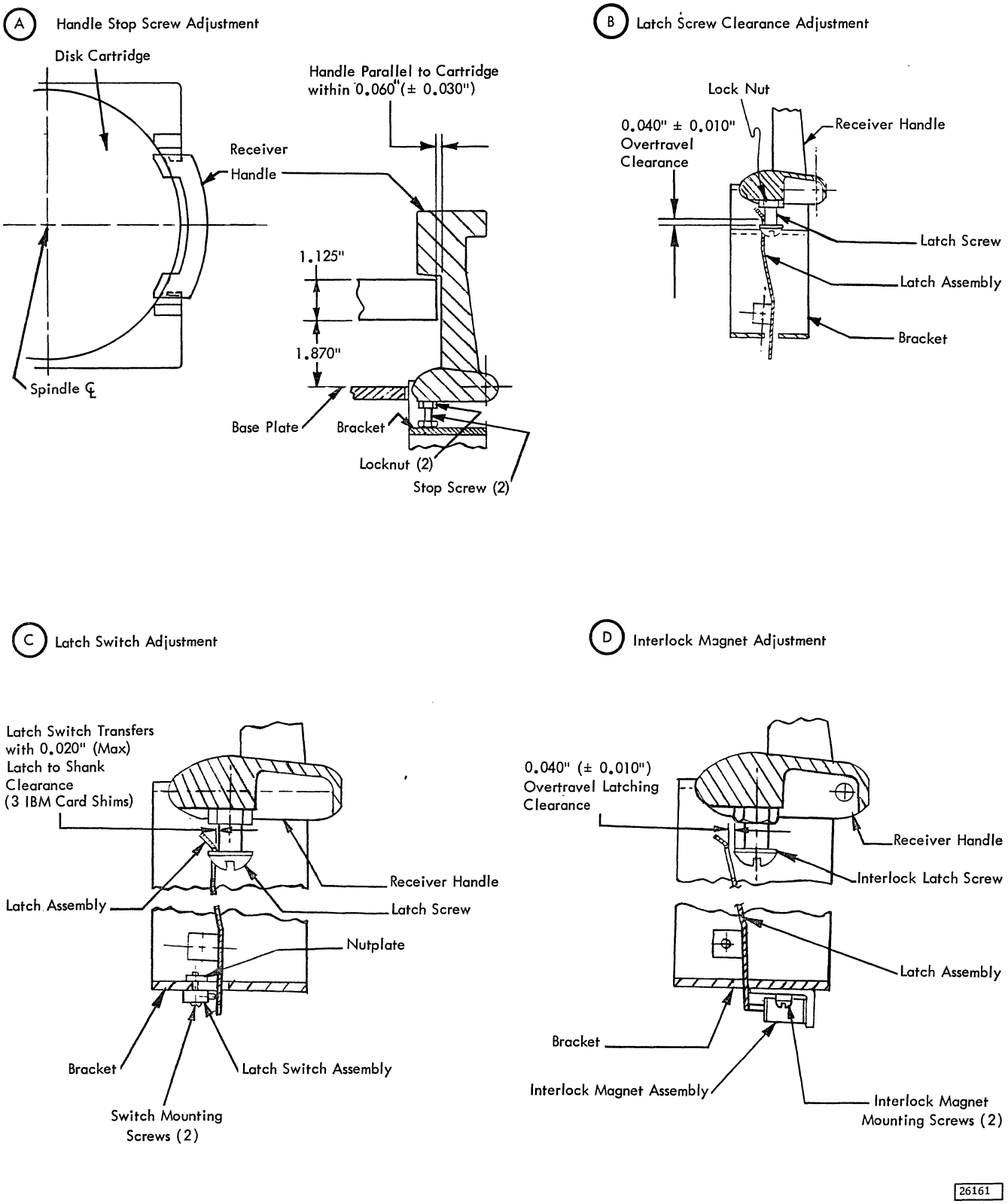


Figure 4-10. Handle and Interlock Adjustment

Latch Screw Clearance Adjustment (View B, Figure 4-10)

NOTE: The interlock handle and bracket assembly must be removed to accomplish this adjustment. (See step 1 above.)

1. Fully rotate handle to the Cartridge In Place position.
2. Adjust the interlock latch screw so that it will seat into the square-hole notch of the latch.
3. Determine that 0.040 (±0.010)-inch overtravel latching clearance exists between the flat surface of the screw and upper edge of notch on the latch. Adjust latch screw as necessary to obtain this clearance.
4. Tighten locknut on latch screw after adjustment has been made.

Latch Switch Adjustment (View C, Figure 4-10)

1. Rotate handle to the Cartridge In Place position to fully engage the latch.

NOTE: The shoulder of the red button will be flush with brown collar of the switch body to denote that switch is in transferred position when the latch is fully engaged.

2. Place three IBM card shims between shank of latch screw and latch. Determine that switch still transfers.

NOTE: The switch should transfer with the latch located 0.020 inch (max.) from shank of latch screw. Transfer of the switch may be checked electrically at the switch terminals, or by listening for the audible click which occurs when switch transfers.

3. Loosen switch screws slightly (so that switch can be repositioned) and operate the latch so that switch will open. Verify that the latch is still engaged with the latch screw by at least half the thickness of the latch, at the time switch opens.
4. Tighten latch switch screws securely to prevent subsequent slippage after this adjustment has been accomplished.
5. Check that the light latch spring succeeds in transferring the switch and then pulling the latch into contact with the shank of the latch screw when a minimum of 5 grams force is applied.

NOTE: Hold assembly in the normal vertical orientation while accomplishing this check. Otherwise, gravity on the latch will distroy the measurement. When the latch rotates away from the latch screw, the switch should transfer while latch is still engaged with the head of latch screw by at least 50% of the latch sheet-metal thickness.

6. Reassemble the interlock handle and bracket assembly to the baseplate by replacing the two mounting screws and restoring the wire connections at pins 3 and 4 on terminal block TB6.

Interlock Magnet Adjustment (View D, Figure 4-10)

Adjustment of the interlock magnet is accomplished to satisfy two conditions which are as follows:

a. The long pole face of the magnet must be parallel to the surface of the latch.
b. When the magnet is energized, unlatching at the latch screw must occur with an over-travel of 0.040-inch.

NOTE: Energizing the magnet may be simulated by manually attracting the latch.

Procedures for adjusting the latch switch are as follows:

1. Loosen the two screws which secure magnet to the interlock bracket. Loosen screws sufficiently so that magnet assembly can be moved, but will maintain its position if not disturbed.
2. Manually rotate the latch to contact the long-pole face of the magnet, and rotate the magnet so that its long-pole face is parallel to the latch.
3. Hold latch against the magnet, and position magnet so that latch clears the head of latch screw by 0.040 (±0.010) inch, with the handle in the Cartridge In Place (raised) position.

4.20 SECTOR TRANSDUCER*

4.20.1 Sector Transducer Index Timing Adjustment (Figure 4-11)

1. Remove CPU signal cable from machine. Loosen transducer lock screw enough so that transducer

*Alternate procedures are contained in Chapter 7 for machines with serial numbers 00001 through 00050.

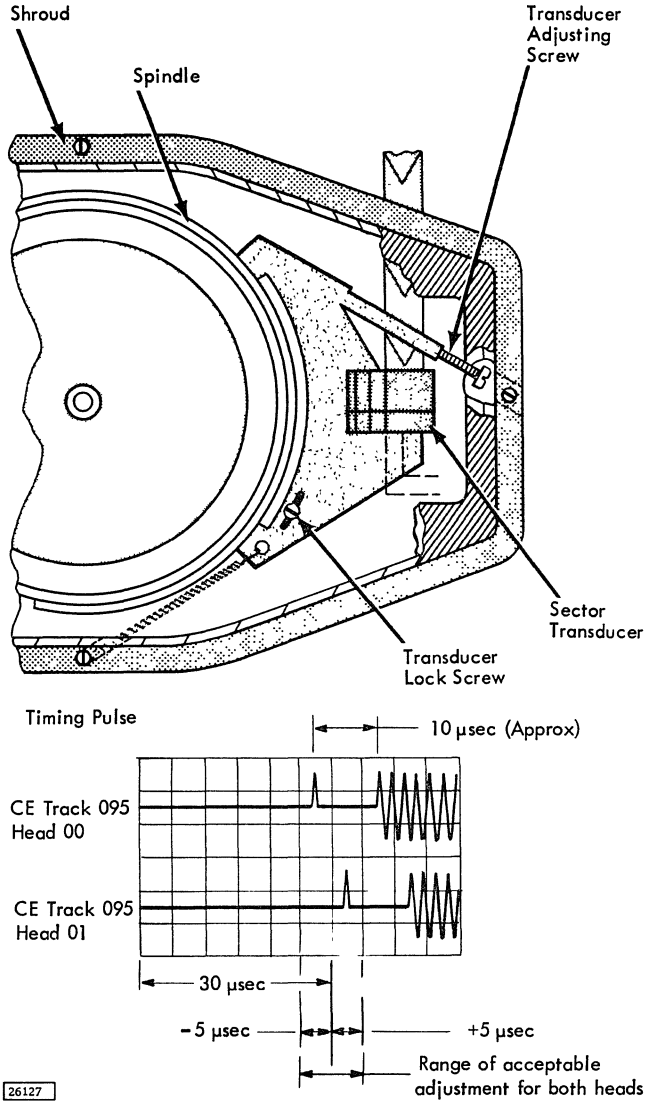


Figure 4-11. Sector Transducer Index Timing Adjustment

can be positioned by the adjusting screw, but is still locked sufficiently to overcome the force exerted by the tension spring.

2. Install CE Cartridge.
3. Power up the machine so that heads will load.
4. Using CE panel, access carriage to track 095.
5. Using a CE oscilloscope, read track 095 by scoping pin D3B07. Synchronize the negative reference on pin K2B04.
6. Observe the time delay from reference pulse to the peak of the timing pulse on track 095. The delay from the leading edge of the reference pulse to the timing pulse should be 30 (±5)µs.

NOTE: The timing pulse precedes the burst of all bits pattern by 10µs.

7. Determine the magnitude and direction (+ or -) of the correction to be made in pulse timing so that a time delay of 30 (±5)µs will prevail for both read/write heads.
8. Use the transducer adjusting screw to position the transducer to increase or decrease the time delay. Turn the screw clockwise to increase the time delay and counterclockwise to decrease the time delay. One turn of the adjusting screw provides a change in time delay

of 78μs. Observe the scope pattern (Figure 4-11) while making this adjustment.

NOTE: Some jitter will be experienced in making this adjustment. The mean timing pulse position is to be used as a reference setting.

9. Power down the machine, remove the CE cartridge and tighten the transducer lock screw to secure the adjustment.
10. Repeat steps 1 through 7 to check the adjustment and readjust according to step 8 if required.

4.20.2 Sector Transducer Removal and Replacement

1. Remove all ac and dc power from machine.
2. Remove cartridge.
3. Back off adjusting screws two or three turns.
4. Remove two binding head screws securing cable clamp to transducer bracket.
5. Remove transducer cable from transducer.
6. Remove single binding head screw securing transducer bracket to baseplate.
7. Lift transducer vertically to remove from baseplate.
8. Replace sector transducer by reversing steps 4 through 7.
9. Insert CE cartridge and check Index Timing adjustment according to Section 4.20.1.

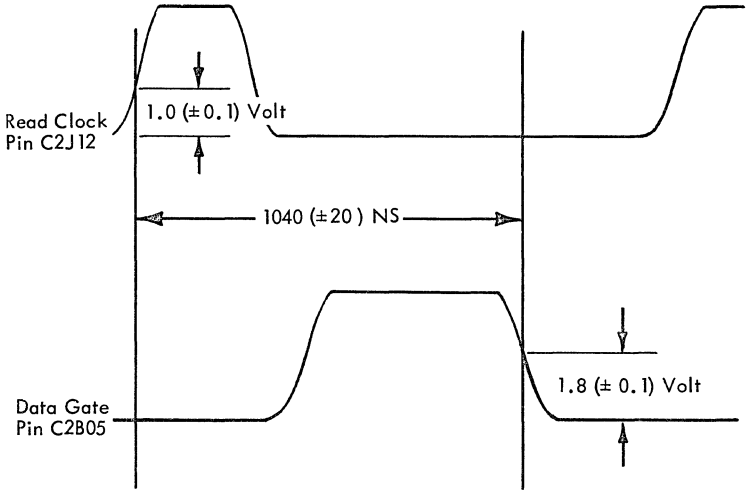
4.21 DATA SEPARATOR

4.21.1 Data Separator Adjustment (Figure 4-12)

The data separator circuit is adjusted to allow for various circuit tolerances to place an electronic gate signal in time coincidence with data bits. A gate signal is formed in the logic circuits of the data separator card to separate Read Clock and Read Data information from the composite double frequency signal. A 5K-ohm potentiometer in the variable 600-nanosecond single-shot circuit is adjusted to achieve this purpose.

The process of adjustment involves displaying separate oscilloscope traces for the output of the 600-nanosecond signle-shot gate signal and the clock signal. To make trace stability and triggering simpler, input to the data separator is received from the write oscillator test-point outputs. Adjustment is accomplished in the following manner:

1. Set up the oscilloscope.
   a. Adjust time base for 200 nanoseconds/cm.
   b. Adjust vertical gain for 1.0 v/cm.
   c. Provide for external synchronization.
2. Using SLT jumpers, connect Test Point H3B05 to D2J10, and connect Test Point H3B13 to D2J09. This connects the output from write oscillator test point to the input of read amplifier.
3. Connect H3B07 to any point on D3D08. This grounds the CPU clock gate and the write oscillator to feed signal to the read amplifier.
4. Connect external synchronization input on the oscilloscope to Read Clock output pin C2B03. Connect the other lead to the 600-nanosecond output pin C2B05. Adjust synchronization to display the dual waveform pattern shown in Figure 4-12.
5. Adjust the 5K-ohm potentiometer on the data separator card so that the trailing edge of the Data Gate pulse is 1040 (±20) nanoseconds from the leading edge of the Read Clock pulse as shown in Figure 4-12.



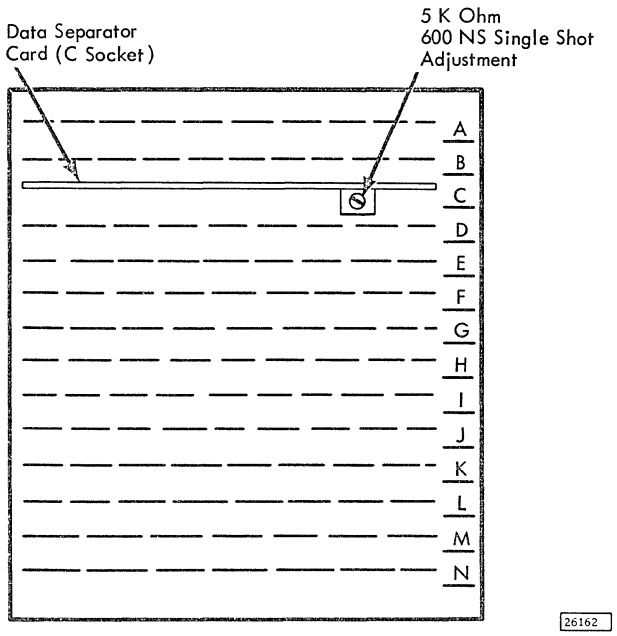


Figure 4-12. Data Separator Adjustment

5.1 POWER REQUIREMENTS

All power required by individual disk storage drives is obtained from system control circuits (Figure 5-1).

Those machines which are installed within a stand alone enclosure (I/O Unit) are connected to power supply circuits which are an integral part of the I/O Unit. Although internal power supply circuits may vary for different system applications, the input power requirements for each disk storage drive is the same. Details of power supply attachment circuits for a given system application are covered in the manual of instruction for the respective system.

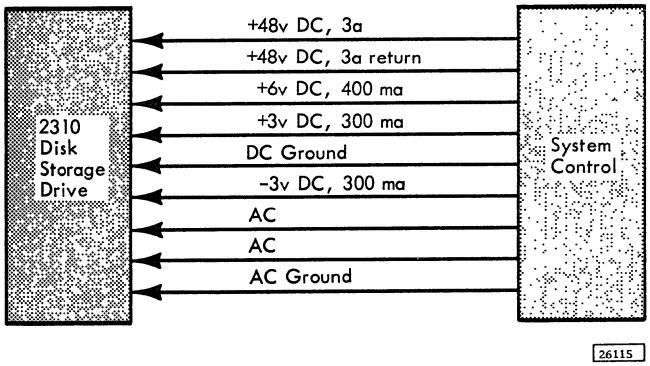


Figure 5-1 Power Lines Interface

5.1.1 AC Input Supply Power

Three versions of the Disk Storage Drive contain the following type primary ac power inputs (Figure 5-2): Internal circuits of the AC box located on the front of the machine receive ac input power and distribute it to machine components.

5.1.2 DC Input Supply Power

DC input power requirements for the Disk Storage Drive are contained in Figure 5-3. DC power is received by the machine at TB1 located on the base plate at the rear of the machine from where it is distributed to machine components.

5.2 POWER SEQUENCING

5.2.1 Power On Sequence

All dc voltages must be at the specified levels before ac power is applied to the drive motor. Blower power must be applied when dc is on.

5.2.2 Power Off Sequence

Ac power to spindle drive motor is removed before removing dc power to machine.

5.3 POWER LINE INTERFACE

5.3.1 Input Power Lines to Disk Storage Drive

Input power lines to the Disk Storage Drive are shown in Figure 5-1.

Machine Version	Use	Voltage (ac)	Tolerance	Phase	Frequency (CPS)	Current
Type I	Blower Disk Drive	115 115	±10% ±10%	Single Single	60 ± 1/2 60 ± 1/2	3 Amp, Start/1 Amp, Run 14 Amp, Start/1.5 Amp, Run
Type II	Blower Disk Drive	208/230 208/230	±10% ±10%	Single Single	60 ± 1/2 60 ± 1/2	2 Amp, Start/0.5 Amp, Run 7.5 Amp, Start/0.8 Amp, Run
Type III	Blower Disk Drive	208/220 208/220	±10% ±10%	Single Single	50 ± 1/2 50 ± 1/2	2 Amp, Start/0.5 Amp, Run 7.5 Amp, Start/0.8 Amp, Run
NOTE: A switch located on the rear of the machine is attached to two terminals and is used to control the disk drive motor by opening and closing a 48-vdc interlock line. The blower should be on whenever dc power is applied to the 2310.						

26136

Figure 5-2. Primary AC Power Inputs

Use	Voltage (dc)	Tolerance	Current
Signal Lines	-3V	± 5%	0.3 Amp
Signal Lines	+3V	± 5%	0.3 Amp
Control Circuits	+6V	± 5%	0.4 Amp
Control and Interlock Circuits	+48V	± 8%	3.0 Amp

NOTE: To prevent damage to internal circuits of the 2310 Disk Storage Drive, the +3 vdc, -3 vdc, and + 6 vdc power must be applied to and removed from the file at the same time. The +48 vdc power must never be applied without all other dc voltages being present.

26137

Figure 5-3. DC Power Inputs

6.1 GENERAL

This chapter consists of general arrangement illustrations of the Disk Storage Drive which show equipment locations within the machine. These illustrations support procedures described in other chapters of the manual and serve as an aid to the CE for accomplishing maintenance operations.

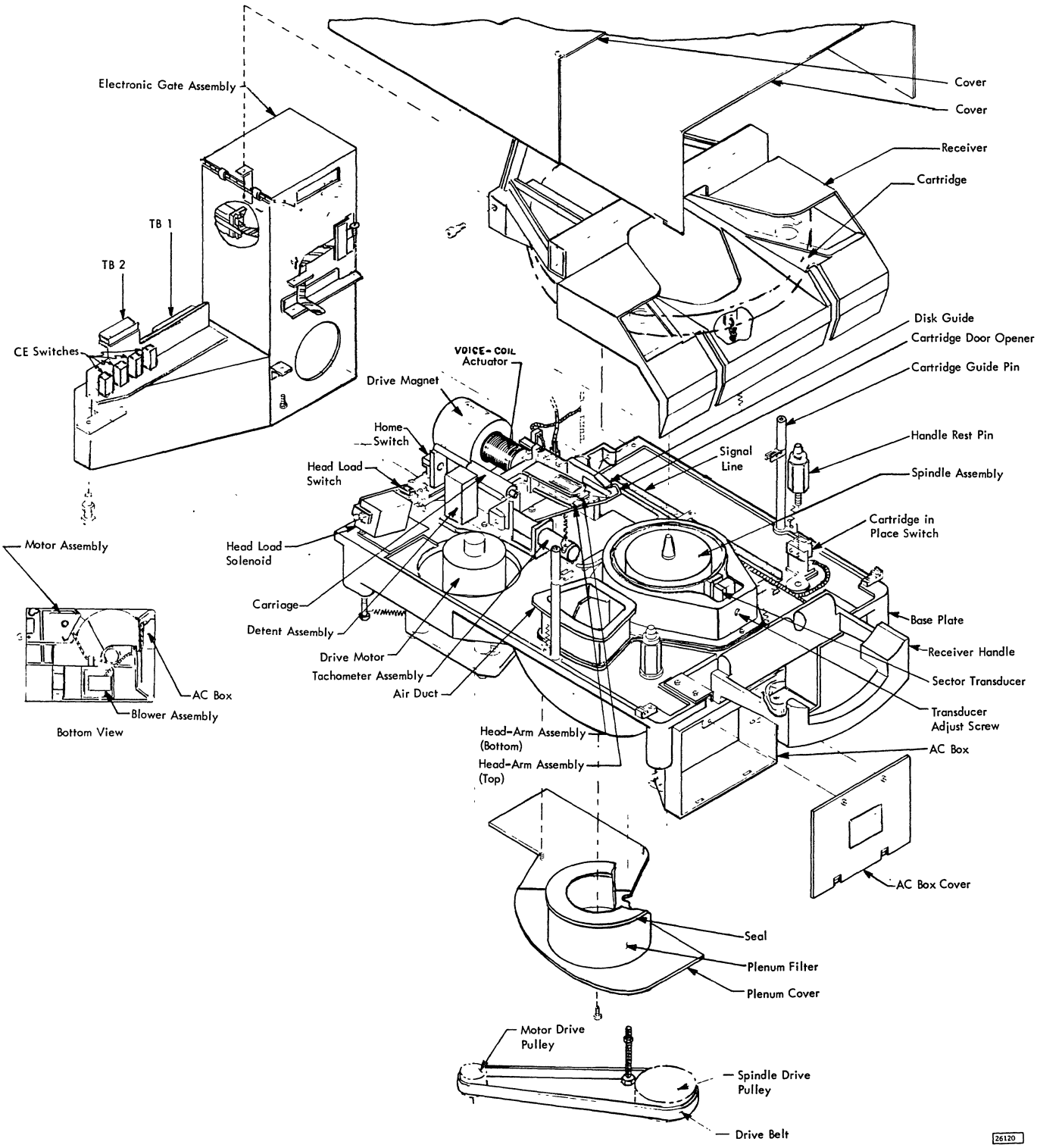


Figure 6-1 Disk Storage Drive, Arrangement of Components

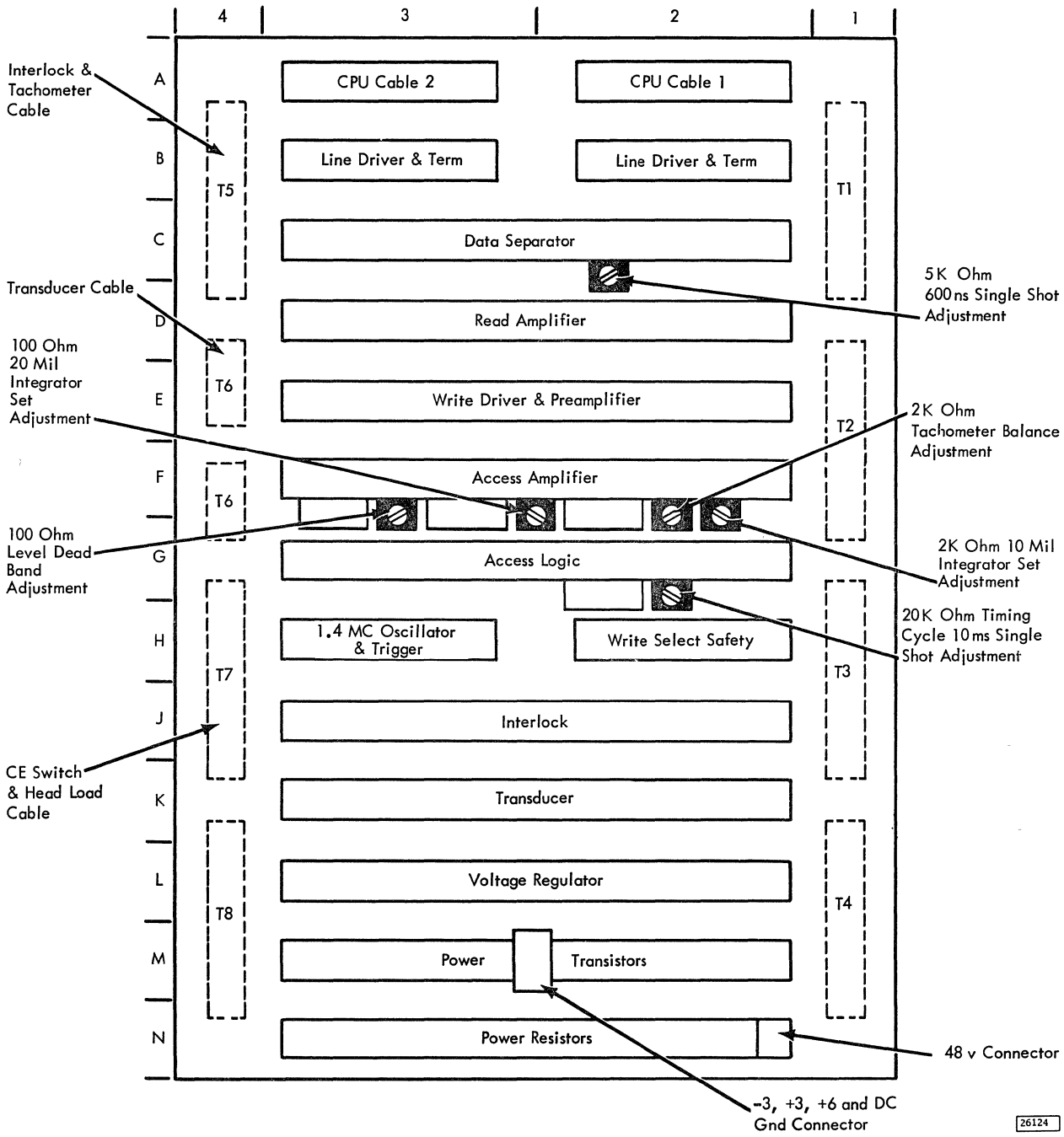
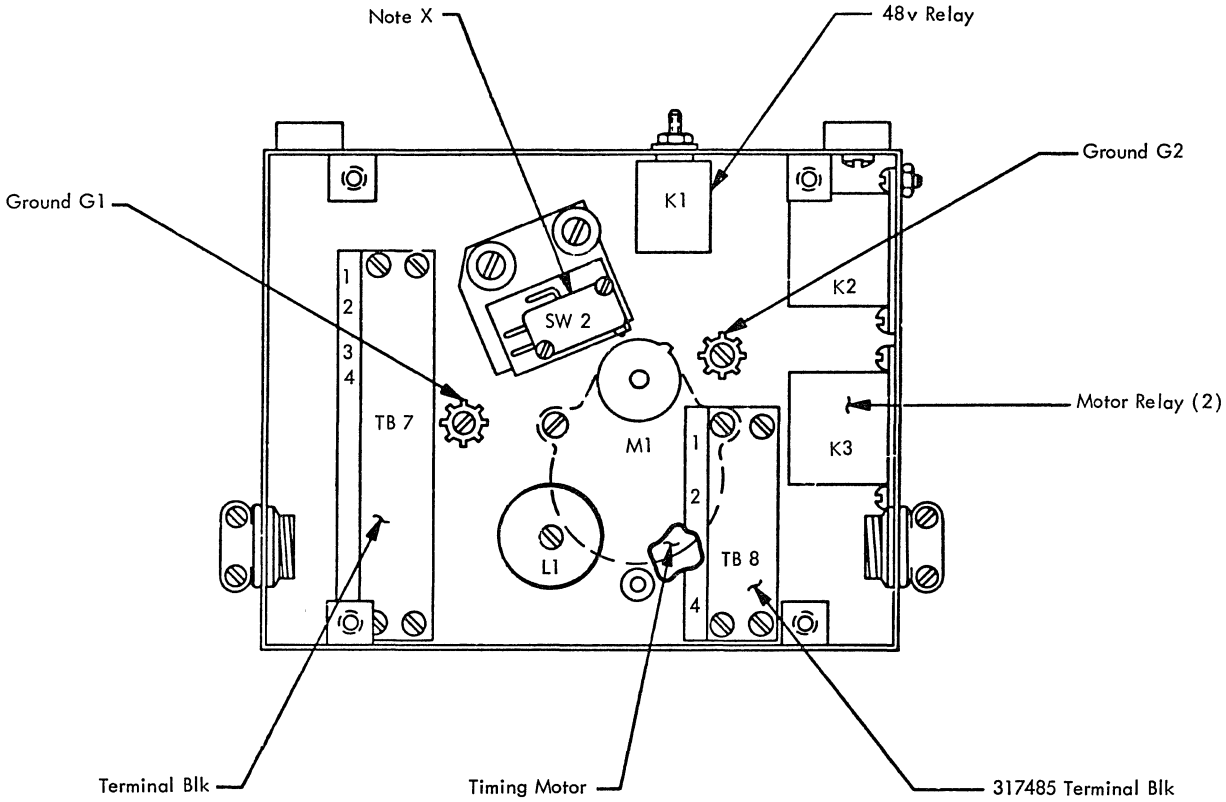


Figure 6-2. Arrangement of SLT Cards in Electronic Gate



Notes: X Sw 2 - Top, Sw 1 - Under Sw 2

Figure 6-3. AC Box, Location of Components

7.1 PURPOSE OF SUPPLEMENT

This supplement provides alternate instructions which are used to maintain Disk Storage Drive machines containing serial numbers 00001 through 00050. This supplement is supported by baseline information located in other chapters of the manual which contain as asterisk and footnote for machine differences applicable to the alternate procedures described in this chapter.

7.2 ALTERNATE MAINTENANCE FEATURES

7.2.1 Identification of Machines

Two different designs of the disk storage drive exist in the field. Although both machines are the same functionally, separate maintenance instructions are required for various mechanical assemblies. Machines can be identified by high order and low order serial numbers stamped on the edge of the base plate, below the drive magnet.

Machines with low order serial numbers, 00001 through 00050, contain differences in design features which are maintained by instructions described in this chapter.

Machines with high order serial numbers, 00101 and upward, are maintained by instructions described in other chapters.

7.2.2 Special Tools

Special tools, which are a part of the shipping group for machines containing serial numbers 00001 through 00050 are as follows:

Feeler Gage, non-magnetic (0.002 inch) (P/N 2200006)

Feeler Gage, non-magnetic (0.005 inch) (P/N 2200007)

Head Alignment Oscilloscope Adapter (P/N 2200052)

Disk Run Out Gage (P/N 2200002)

The Disk Run Out Gage (Figure 7-1a) enables the CE to determine the extent of warpage present in a disk by measuring the amount of vertical deflection present at the outer edge of the disk.

The Disk Run Out gage, used for machines with serial numbers 00001 through 00050, has a different shape and part number than the gage specified in Chapter 2, although its attachment to the base plate, and its use, is identical.

This gage is mounted on the base plate adjacent to the head arm assemblies, so that the disk can be manually rotated between the gap on adjustable lips of the gage. A knurled adjusting screw on the gage permits adjusting the gap to determine runout. Procedures for using the gage are described in Section 4.2.3.

7.2.3 Branch Office Tools

The following tools are available at the Branch Office:

CE Disk Cartridge (P/N 2200001)

This tool is identical to that described in Chapter 2.

Disk Cleaning Fixture (P/N 2200008)

This tool is identical to that described in Chapter 2.

7.3 PLENUM COVER AND FILTER

7.3.1 Plenum Cover Removal and Replacement

The complete plenum cover is composed of two sections, one of which can be removed. The removable section can be identified as that section through which the spindle pulley protrudes.

1. Remove drive belt. (Refer to Section 4.1.1.)
2. Remove eight mounting screws (Figure 7-1b) securing plenum cover to baseplate. One of these screws secure the belt guard to plenum cover.
3. The plenum cover can now be lowered vertically from baseplate of the machine.
4. Replace plenum cover by reversing Steps 1 and 2.

7.3.2 Plenum Air Filter Removal and Replacement

1. Remove drive belt. See Section 4.1.1.
2. Remove plenum cover. See Section 7.3.1.
3. The air filter can be lowered vertically downward.

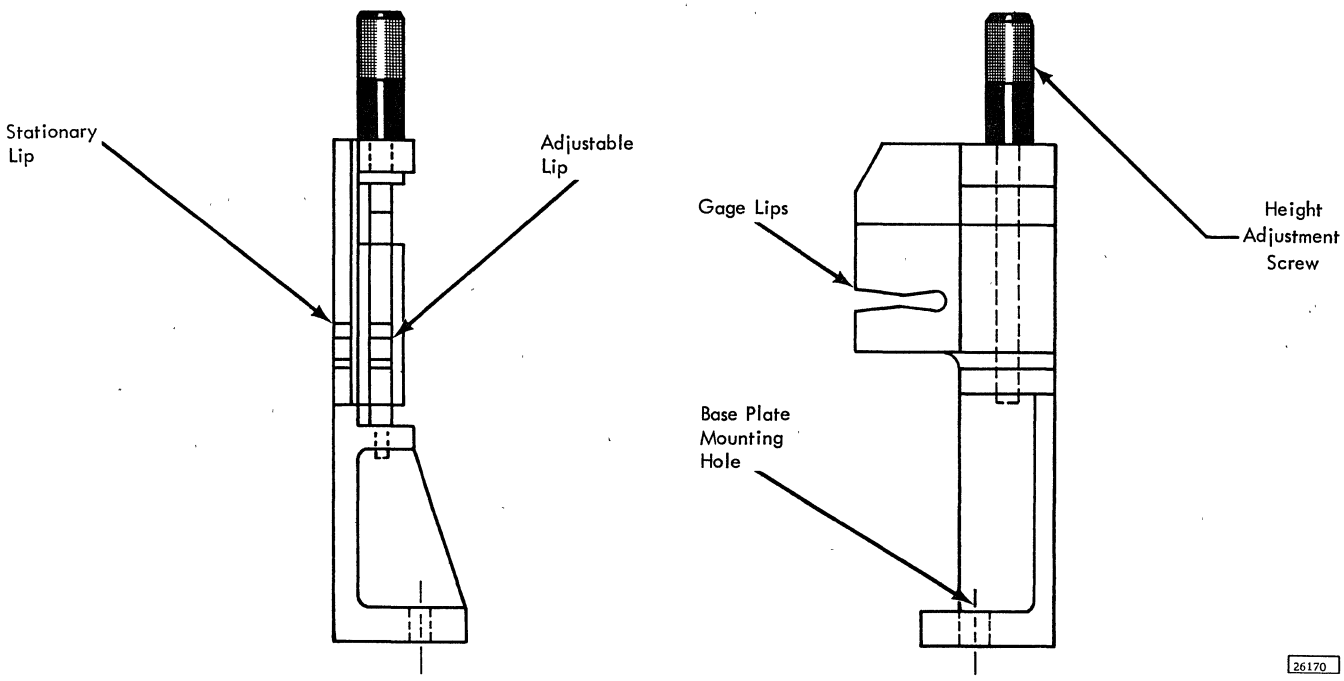


Figure 7-1a. Disk Run Out Gage

4. Replace air filter by reversing steps 1, 2, and 3.

WARNING: When replacing plenum air filter, make certain that the foam-rubber seal is between the air filter and base plate. If this seal is not in its proper position, leaks can result which will allow foreign particles to be blown into the cartridge. Also, clean the plenum cover and cartridge air duct with lint-free tissue dampened with 91% Isopropyl Alcohol to remove accumulated particles.

7.4 BLOWER ASSEMBLY

7.4.1 Blower Assembly Removal and Replacement (Figure 7-1)

1. Turn off all ac and dc power to machine.
2. Disconnect blower motor leads from terminal strip located in ac box.
3. Remove three binding-head mounting screws securing blower motor mounting bracket to baseplate.
4. The blower may now be lowered vertically away from the baseplate.
5. Replace blower assembly by reversing steps 1, 2, 3, and 4.

NOTE: There is a gasket between the inlet to blower assembly and electronics gate. Be sure this gasket is properly positioned to prevent excessive openings in this area.

7.4.2 Blower Motor Removal and Replacement

Same as Section 4.4.4, except motor installation does not contain clamps at the end rings.

7.5 ACTUATOR ASSEMBLY

7.5.1 Actuator Assembly Removal and Replacement

The entire carriage and mount of the actuator assembly may be removed as a unit as follows:

1. Shut off all power to the machine and remove cartridge.
2. Disconnect read/write head cables from receptacles and remove the clamp which secures the cable receptacles.
3. Unsolder home switch leads and mark each lead with a different colored grease pencil to facilitate identification.
4. Remove tachometer leads and drive coil leads from terminal strip and note terminal from which each lead is removed.

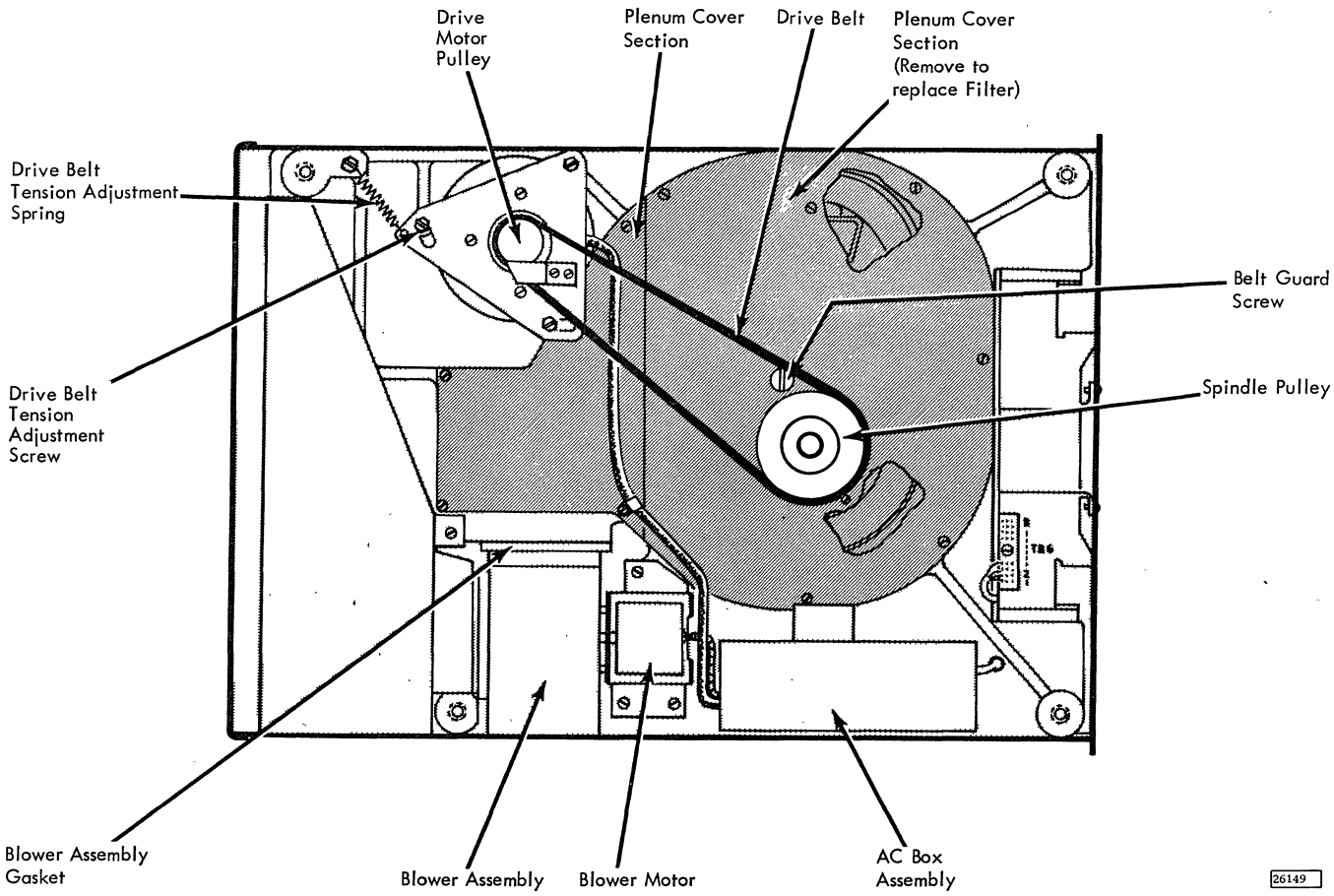


Figure 7-1b. 2310 Disk Storage Drive, Bottom View of Machine

5. Remove retaining ring from pivot pin in head-load solenoid plunger and slide pivot pin out of plunger.
6. Disconnect the spring attached to the cartridge door opener and remove the air baffle mounted between actuator and shroud. Remove the disk guide located adjacent to the actuator assembly.
7. Remove tachometer bracket mounting screws to unfasten tachometer assembly from actuator assembly.
8. Remove the five socket head mounting screws which secure the actuator assembly to the base plate.
9. Lift carriage drive assembly vertically off the two dowel pins in carriage mounting base, and the single dowel pin on tachometer mounting bracket.

CAUTION: Ensure that correct leads are matched for terminals of the tachometer assembly and voice coil after replacing the actuator. Reversal of these leads would cause uncontrolled carriage motion resulting in damage to equipment.

10. Replace actuator assembly by reversing steps 2 through 10. Check head load adjustment and readjust if necessary (see Section 7.8.2).

7.6 DRIVE MAGNET

7.6.1 Drive Magnet Removal and Replacement

1. Turn off all power to the machine.
2. Push the carriage forward as far as it will extend.
3. Remove the three binding-head mounting screws.

NOTE: Access can be gained to the screws nearest the electronics gate by opening gate and removing filter from gate.

WARNING: Do not force the magnet to slide out of the mounting bracket since damage to drive coil, mounting base, and magnet mounting spacers would result. With a moderate force, the magnet will slide smoothly out of the mounting bracket. Do not drop or hammer on the magnet since this could destroy the epoxy joints binding the face plates to the permanent magnet. When the magnet is out of the machine, place masking tape over the flux gap to prevent particle accumulation. When replacing the magnet, be certain that mounting spacers are seated in their respective counterbore recesses.

4. Slide magnet horizontally away from carriage.
5. Replace drive magnet by reversing steps 2 and 3. If a new magnet is installed, perform the drive magnet adjustment described in Section 7.6.2.

7.6.2 Drive Magnet Adjustment

Adjustment of the drive magnet (Figure 7-2) is to be accomplished whenever a new drive magnet is installed. This adjustment prevents binding which could cause distortion of the base and result in misalignment of the carriage.

The threaded sleeve located outboard on the actuator mounting bracket must be positioned to provide a 0.0005-inch clearance with the drive magnet spacer which is located inboard on the mounting bracket.

1. Remove the mounting screw, and loosen the locknut which secures the sleeve against the spacer.
2. Use a feeler gage to obtain the 0.0005-inch clearance between the spacer and sleeve.
3. Tighten the locknut after the 0.0005-inch clearance is obtained and replace the mounting screw.

7.7 DETENT ASSEMBLY AND DETENT RACK

7.7.1 Detent Assembly Removal and Replacement

1. Disconnect detent coil leads from terminal strip. Mark the pin location of each lead prior to removal to facilitate identification.
2. Remove three socket-head mounting screws securing detent assembly to carriage mounting base.
3. Remove detent assembly by lifting it upward away from carriage assembly.
4. Replace detent assembly by reversing steps 1, 2, and 3. Insert mounting screws, but do not tighten at this time. Adjust detent assembly (refer to section 7.7.2).

7.7.2 Detent Assembly Adjustment (Figure 7-3)

WARNING: The only two CE adjustments required for the detent assembly are the pawl-to-rack alignment and the electromagnet air-gap alignment spacing. Do not, under any circumstances, loosen bolts holding the springs, spring post, spring mount, or electro-magnet.

1. Turn off all power to the machine.
2. Loosen three socket-head cap screws securing detent assembly to actuator assembly. Loosen screws until detent assembly will slide, without rocking, toward and away from detent rack.
3. Push registration ledge of detent assembly against the corresponding edge of carriage mounting base (Figure 7-3). Slide detent assembly along this edge until a gap of 0.007 (±0.003) inch is formed between either the odd or even pawl and a detent crown tooth of the detent rack. (If necessary, move carriage to align a crown tooth of detent rack with a pawl.) Tighten the three socket head mounting screws to secure this adjustment.
4. Check adjustment made in step 3. Repeat step 3 if necessary.
5. Remove CPU signal cable from processor so that CE switches can be used to control accessing.
6. Turn on power to machine and insert CE disk cartridge.

WARNING: The CE disk cartridge must be inserted before continuing with the procedure.

7. Upon completion of step 6, one detent coil is energized. Give carriage a slight push to ensure full engagement between rack and detent pawl.
8. Loosen # 0-80 nut (Figure 7-3) on the energized detent coil using a 3/16-inch End Wrench.
9. Use a fine blade screwdriver to turn the knurled (serrated) portion of the gap-adjuster nut (Figure 7-3) until an air gap between the clapper and pole pieces is within 0.004 (+ 0.001, -0.002) inch width. Use non-magnet shims to check this air gap measurement. Do not apply excessive force on the adjustment because too much

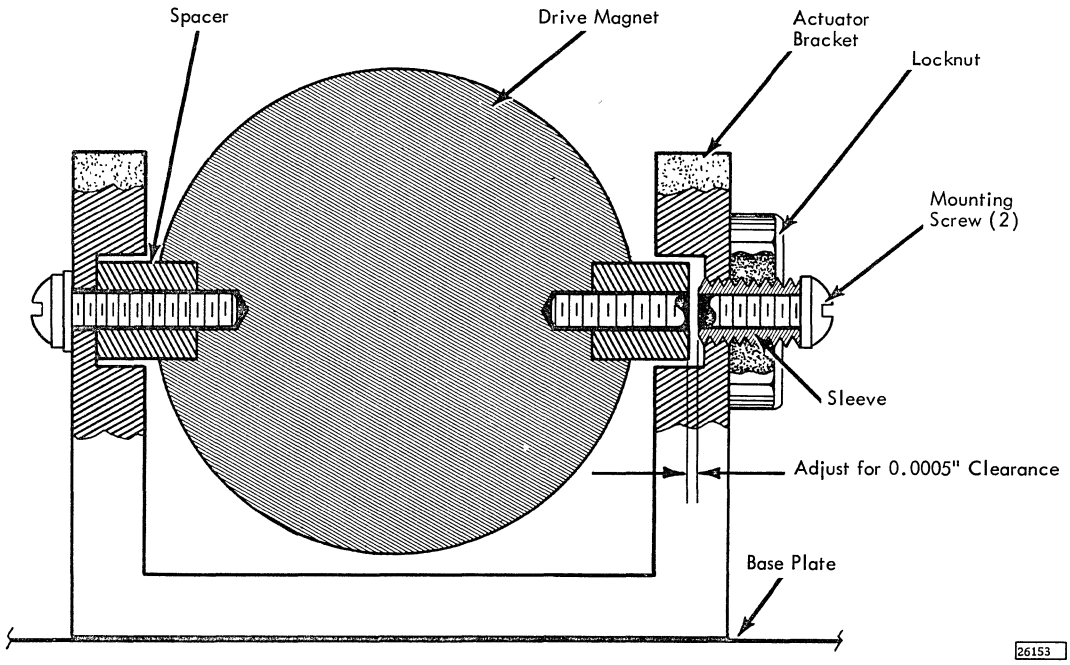


Figure 7-2. Drive Magnet Adjustment

force will cause deflection of the spring supported clappers resulting in an uneven gap. When the proper gap is achieved, tighten the #0-80 nut by applying 15 to 20 inch-0z of torque.

NOTE: The required 15 to 20 inch-0z of torque can be applied by loading the free end of the end wrench with 170 to 225 grams, using a gram gage. The 170 to 225 gram load must be applied at a right angle to the shaft of the end wrench.

10. Set the CE Step Mode switch to 10 milli-inch steps. Using the CE Step Control switch, move carriage one track (0.010-inch). The other detent pawl should now be engaged with the rack.
11. Move carriage slightly to check for good contact between pawl and rack engagement.
12. Repeat Steps 8 and 9 for the second detent.
13. Turn off all power to the machine.
14. Replace CPU signal cable on processor.

NOTE: The Read/Write head must be adjusted with a CE Cartridge installed after each adjustment of the detent assembly has been accomplished.

15. Adjust read/write head (See Section 7.15.1).

7.7.3 Detent Rack Removal and Replacement

Removal

1. Remove detent assembly (Refer to section 7.7.1).
2. Remove two binding-head mounting screws that secure detent rack (Figure 7-4) to the carriage.
3. Lower detent rack to remove from carriage.

Replacement

1. Place detent rack in position shown in Figure 7-4. Press upward on rack to ensure contact between registration surfaces on detent rack and registration ledge on carriage (Refer to section 7.7.4 for details of adjustment).
2. Install two binding-head mounting screws to secure the installation.
3. Check detent adjustment by observing clapper spacing and detent alignment with the rack.

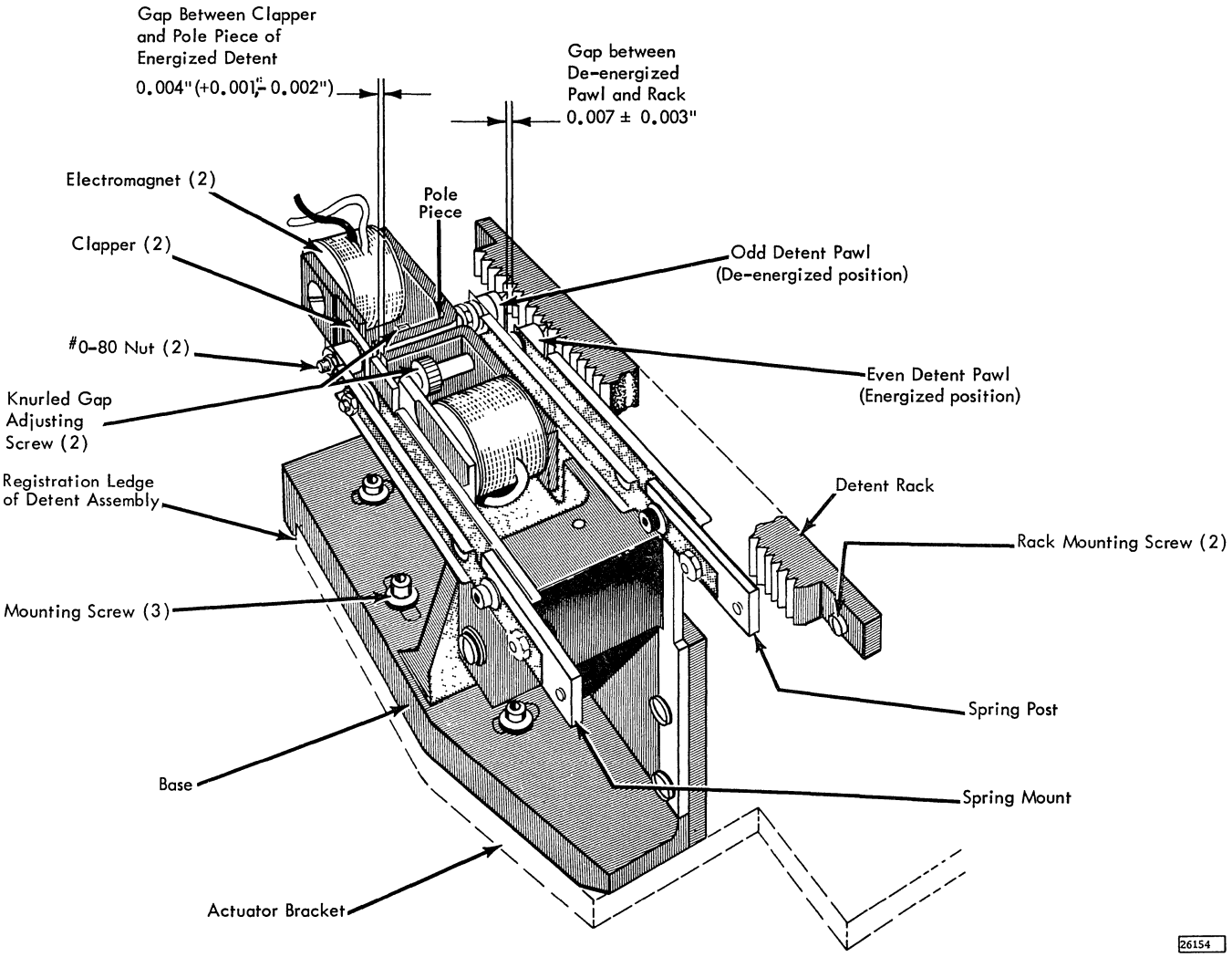


Figure 7-3. Detect Assembly, Adjustment

4. Realign Read/Write head. (Refer to section 7.15.1).
5. Adjust Crash Stops (Refer to section 4.10.1 and 4.10.2).
6. Adjust Home Switch (Refer to section 7.11.2).
7. Replace detent assembly (Refer to section 7.7.1).

7.7.4 Detent Rack Adjustment

NOTE: Adjustment of the detent rack (Figure 7-4) is accomplished during replacement and should never be loosened or readjusted after it is initially installed on the carriage.

When a detent rack is replaced (section 7.7.3), its right end (as viewed from the direction of the detent assembly) should be flush (± 0.001-inch) with the right end of carriage. The top registration surfaces of detent rack must be pressed to establish a flush contact with the registration ledge of carriage. The two mounting screws must be tightened to secure the detent rack alignment.

7.8 HEAD LOAD ASSEMBLY

7.8.1 Head Load Solenoid Removal and Replacement

1. Turn off all ac and dc power to machine.

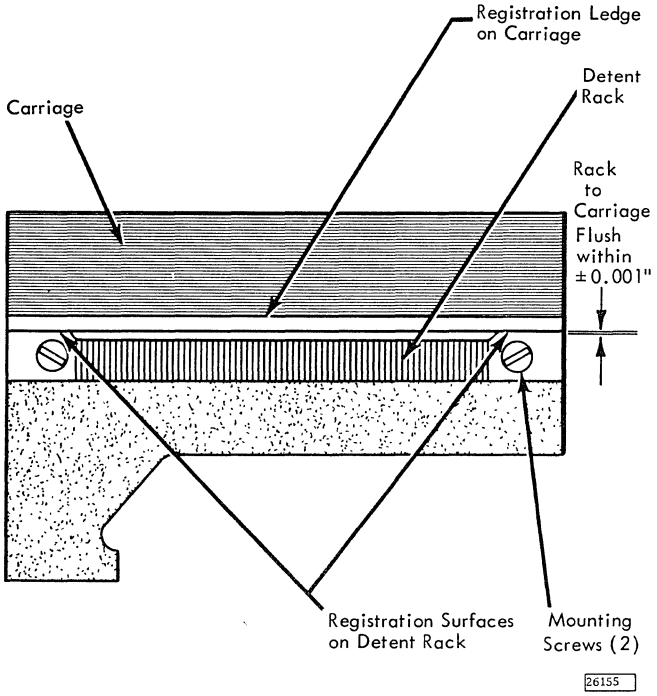


Figure 7-4. Detect Rack, Removal and Replacement

2. Remove solenoid leads from terminal strip TB4 (pins 7 and 8).
3. Remove pivot pin from solenoid plunger.
4. Remove two binding head screws securing solenoid to mounting bracket.
5. Slide solenoid horizontally away from bracket to effect removal.
6. Replace the head load solenoid by reversing steps 1 through 5. Readjust head load assembly (section 7.8.2).

7.8.2 Head Load Assembly Adjustment (Figure 7-5)

WARNING: Do not load heads when disk is not rotating in machine. When cartridge is out of machine, insert an IBM card between heads prior to loading. Failure to comply will result in damage to heads and/or disk.

1. Remove CPU signal cable from plug connection on machine.
2. Install a CE cartridge in machine.
3. Power up the machine and check for loading of heads.

NOTE: Read/Write heads should load after a 90-second delay. If heads fail to load, use the following procedure to accomplish head loading:

a. Observe that solenoid plunger has bottomed out.
b. Shut off power to machine.
c. Loosen the two binding head screws that secure the head load solenoid to the mounting bracket.
d. Use the solenoid adjust screw (0.031-inch per turn) to move the solenoid forward or backwards in the bracket. If solenoid plunger has bottomed out, move the solenoid backwards approximately 0.031-inch. If solenoid has not bottomed out, move solenoid forward approximately 0.031-inch.
e. Tighten the two mounting screws to secure the adjustment.

4. Use masking tape to hold the heads loaded switch in the transferred position. Loosen the switch mounting screws and slide the switch backwards toward the solenoid as far as possible.

WARNING: If the Heads Loaded switch is not held in transferred position, 48 vdc will be applied to solenoid coil resulting in damage to equipment.

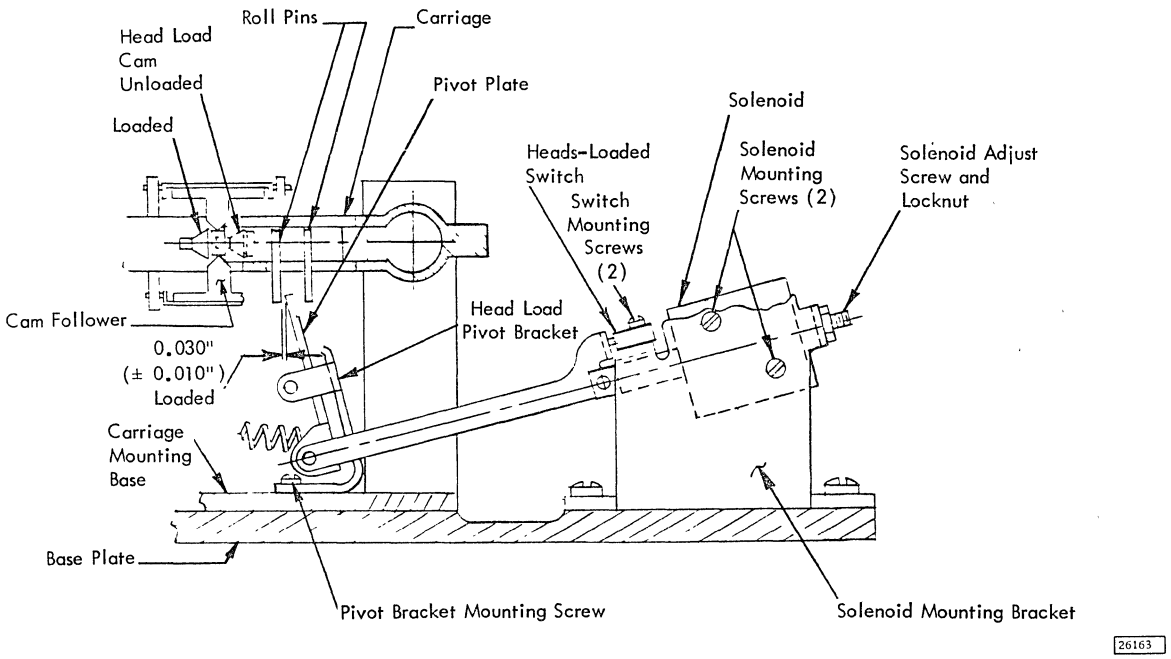


Figure 7-5. Head Load Assembly Adjustment

5. With the carriage detented at track 000, loosen the two solenoid mounting screws and the solenoid adjusting screw. Slide the solenoid backward until the pivot plate contacts the head-loading roll pin in the head load cam. Continue to slide the solenoid back until the cam moves all the way into the cam followers. Tighten the solenoid mounting screws and position the solenoid adjusting screw against the back of the solenoid.
6. Back off the solenoid adjusting screw one turn, and tighten the lock nut. Loosen the solenoid mounting screws and slide the solenoid backward so that it will bear lightly against the adjusting screw.
7. Check clearance between the pivot plate and loading roll pin. This clearance should be within 0.030 (±0.010) inch. Tighten the solenoid mounting screws after this clearance has been obtained.
8. Access the carriage to track 199. Use a dental mirror to check for a minimum clearance of 0.010 inch between the pivot plate and the head loading roll pin while the carriage is positioned at track 199. This check determines parallelism between the carriage rail and pivot plate.
9. Shut down the machine and manually move the carriage between the forward and rear crash stops. There should be a minimum clearance of 0.010 inch between the pivot plate and the head unloading roll pin for all carriage positions.
10. If conditions of parallelism between the pivot plate and roll pins in steps 8 and 9 are not apparent, it will be necessary to adjust the pivot bracket to obtain the required clearances. This is accomplished by first loosening the forward mounting screw of the pivot bracket, then loosening the rear mounting screw 1/8-turn each, and tapping the forward end of the bracket in the proper direction to obtain parallelism.

NOTE: It may be necessary, in some instances, to move the rear end of the pivot bracket also, to obtain the 0.010 inch clearance for parallelism.

11. Repeat steps 5 through 9 to ensure that other adjustments have not been altered.
12. Adjust heads loaded switch using the following procedure.
    a. Slide switch toward head load contact point against the head load actuator link and remove the masking tape.

b. Place a 0.005 inch shim between switch button and link. Move switch until it bottoms out.
c. Tighten mounting screws to secure switch in this position.

CAUTION: Feel the head loaded solenoid coil by hand to inspect for overheating. The solenoid coil is warm to the touch during normal operation when 24 vdc is applied. A defective Heads Loaded Switch adjustment will cause 48 vdc to be applied to the coil resulting in excessive heating. If the coil is too hot to grasp and hold, the heads loaded switch is not in proper adjustment.

13. Adjust the heads loaded switch if solenoid coil is excessively hot (refer to procedures of section 7.8.3).
14. Power down the machine.

7.9 HEAD LOAD SPRING ASSEMBLY

NOTE: Removal and replacement of the head load spring assembly is the same as described in Chapter 4. Do not replace the counterbalance spring assembly whenever a new head load spring assembly is installed.

7.9.1 Head Load Spring Assembly Counterbalance Spring Adjustment

NOTE: The head load counterbalance spring is not installed on all machines, and this spring is not to be replaced whenever a new head load spring is installed on machines. These procedures apply to those machines which still incorporate the head load counterbalance spring.

Adjustment of the counterbalance spring is to be accomplished as follows:

1. With heads unloaded, position the counterbalance spring perpendicular to the side of the head load spring support.
2. Check the force required to lift the spring support off of the head. This force is measured at the tab on the spring which contacts the head. If this force is not 4 (±1) grams at the top head, and 9 (±1) grams at the bottom head, form the associated counter balance spring at the bend nearest the mounting screw to deliver the required force.
3. Repeat step 2 to ensure that the required force is maintained.

7.10 CRASH STOPS

NOTE: Adjustment of front crash stop is the same as described in Section 4.10.1.

7.10.1 Rear Crash Stop Adjustment

Use appropriate switches on the CE Panel to operate carriage in a reverse direction to detent on track 000 against rear crash stop (near drive magnet).

NOTE: It may be necessary to move the home switch out of the way to accomplish the rear crash stop adjustment.

Adjust screw on left end of rear crash stop and tighten locknut so that a 0.003, (±0.001) inch clearance exists between rear crash stop and carriage.

Operate carriage, first in forward direction and then reverse, to check that the 0.003, (±0.001) inch clearance adjustment is maintained at the rear crash stop when carriage is detented on track 000.

NOTE: If the Home Switch was moved to accomplish adjustment of the rear crash stop, it must be readjusted as described in Section 7.11.2.

7.11 HOME SWITCH

7.11.1 Home Switch Removal and Replacement

1. Remove all ac and dc power from machine.
2. Remove leads from Home Switch terminals.
3. Remove two binding head screws securing Home Switch mounting bracket to actuator bracket.
4. Remove binding head screws securing switch to mounting bracket.
5. Replace Home Switch by reversing steps 2 through 4 and adjust switch according to Section 7.11.2.

7.11.2 Home Switch Adjustment

1. Use appropriate switches on the CE Panel to operate carriage in a reverse direction to detent on track 001.
2. Place a 0.007-inch feeler gage between the carriage and Home Switch pushbutton and adjust the Home Switch adjusting screw until the switch just transfers.

3. Check this adjustment with a 0.005-inch feeler gage to determine that Home Switch will not transfer.

7.12 TACHOMETER AND TACHOMETER EXTENSION ROD

7.12.1 Tachometer Extension Rod Removal

1. Remove outboard adjusting nut which secures rod to carriage arm.
2. Loosen inboard adjusting nut sufficiently to free rod from carriage arm.
3. Slide extension rod away from home switch and out of the tachometer coil and housing assembly.

WARNING: Exercise care to avoid bending the rod or scoring the core as rod is extracted from shield.

4. Replace tachometer extension rod by reversing steps 1, 2, and 3.

7.12.2 Tachometer Extension Rod Adjustment

The tachometer extension rod (Figure 7-6) is adjusted so that when the carriage is dented in track 000, the shoulder of the rod protrudes 0.137, (±0.010) inch from the carriage end of the tachometer. This adjustment is performed as follows:

WARNING: Use extreme care to avoid bending the tachometer extension rod while making this adjustment.

1. Detent carriage to track 000.
2. Loosen the two locking nuts where rod attaches to arm extending downward from carriage. As a point of reference, advance the inboard nut. This will push the extension rod further into the tachometer. Continue this process until the extension rod shoulder is flush with the end of the tachometer.

NOTE: This distance can be judged within 0.010-inch by eye (See Figure 7-6).

3. Back off the inboard nut by 5-1/2 turns from the reference position obtained in step 2. Since the nut advances 0.025-inch per revolution, the total movement will be 0.137 inches.
4. Hold the inboard nut firmly to prevent rotation, and tighten the outboard nut. In accomplishing this step, apply sealant (P/N 2111360) to secure the adjustment from vibration. If the assembly is equipped with an outboard lockwasher, omit the use of sealant to secure the adjustments.

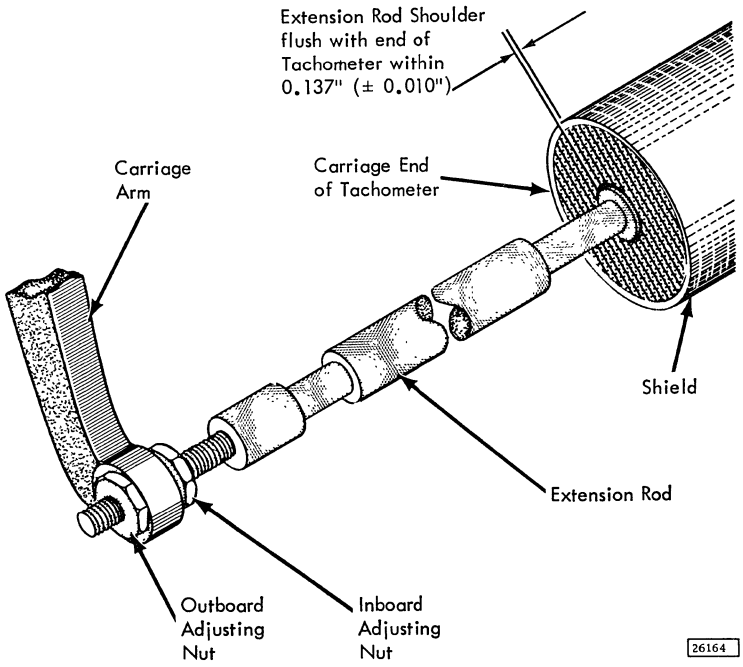


Figure 7-6. Tachometer Extension Rod Adjustment

5. Check the carriage for friction to ensure that binding does not prevail as a result of making the tachometer extension rod adjustment.

7.12.3 Tachometer Assembly Removal and Replacement

1. Remove disk cartridge from machine.
2. Remove cartridge receiver, shroud, and spindle from baseplate.
3. Unsolder tachometer leads from terminal strip on tachometer bracket. Mark each lead to facilitate identification.
4. Remove tachometer extension rod according to section 7.12.1.

WARNING: Caution must be exercised in handling tachometer core and extension rod. The extension rod can be bent, and core broken if dropped.

5. Remove two set screws (one located in carriage mounting base and one located in tachometer bracket) which secure the tachometer shield.
6. Slide tachometer shield out of carriage mounting base and tachometer bracket.
7. Slide tachometer coil and housing assembly out of tachometer shield.

WARNING: Slide coil and housing assembly out the end of tachometer shield nearest the spindle. Do not bend tachometer electrical leads back and forth since they can break within the coil and housing assembly.

8. Replace the tachometer assembly by reversing steps 2 through 7 and adjust according to section 7.12.2.

7.13 CARRIAGE RAIL

7.13.1 Carriage Rail Removal and Replacement

1. Turn off all ac and dc power to the machine and remove top baseplate cover.
2. Loosen two set screws, which eliminate side-play of rail, sufficiently to allow the rail free movement.
3. Insert 0.100-inch feeler gage shim between the carriage preload spring and carriage. Remove preload force on the rail, and slide the rail out of the carriage mounting base being careful to avoid misalignment.

WARNING: Misalignment in this step could damage the carriage bearings.

4. Replace carriage rail by reversing steps 2 and 3.

NOTE: After carriage rail has been replaced, test carriage rail for movement in the direction of carriage motion. If any movement is apparent, sufficiently tighten set screws located in the rail supports until movement disappears.

7.14 CARRIAGE SUBASSEMBLY

7.14.1 Carriage Subassembly Removal and Replacement

1. Remove all ac and dc power to machine.
2. Remove Drive Magnet (section 7.6.1).
3. Loosen binding head screw securing head plug clamp to release head plug. Disconnect head plugs from head cables.
4. Remove tachometer extension rod from carriage (section 7.12.2).
5. Unsolder voice coil leads and note terminal from which each lead is removed.
6. Remove two binding head screws securing carriage outrigger slide to carriage. Remove slide.
7. Remove carriage rail (Section 7.13.1).
8. Lift carriage assembly vertically away from carriage mounting base.

WARNING: Caution must be exercised to ensure that read/write heads do not strike anything during removal.

9. Replace carriage subassembly by reversing steps 2 through 7.

WARNING: When replacing the plastic outrigger slide, be certain that the slide does not touch, and is parallel to the vertical surface of its guide in the carriage mounting base.

10. Adjust tachometer extension rod according to section 7.12.1.
11. Adjust head-arm assemblies according to section 7.15.1.
12. Perform the following adjustments if a new carriage subassembly has been installed:
    a. Check detent adjustment and readjust if necessary according to section 7.7.2.

b. Adjust front and rear crash stops according to section 4.10.
c. Adjust home switch according to section 7.11.2.

7.15 HEAD-ARM ASSEMBLY

7.15.1 Head-Arm Assembly Adjustment

NOTE: The requirements for aligning read/write heads by using track 100 of the OE cartridge to obtain the oscilloscope display patterns Figure 4-8, Section 4.17.1 are identical for machines with serial numbers 00001 through 00050.

The location of the head adjustment screw, which is accessible from inside the voice coil (Figure 7-7) requires that the drive magnet be removed to gain access to this screw.

Procedures for adjustment of the head-arm assembly are as follows:

1. Remove drive magnet from the actuator according to procedures of section 7.6.1 to gain access to the head adjusting screws.
2. Torque both head clamping screws to 3.5 (±1.0) pound-inches.
3. Back off the head adjusting screws and push each head-arm assembly back toward the voice coil until the head load spring just clears the potted capsule on the head. A dental mirror is required to observe the lower head.
4. Install the CE cartridge and apply power to the machine to load heads. Manually move the carriage to track 100 and detent by energizing the even detent coil.

NOTE: Operate the CE Step Mode switch to energize the even detent coil. Ensure that carriage is still positioned at CE track 100 when detent engages rack.

5. Allow the machine and cartridge to operate continuously for 15 minutes to ensure that temperature stabilization has taken place before adjusting heads.
6. Scope from Pin D3B07. Set time base to display 5 ms/cm (one revolution of the disk is 40 ms). Synchronize the oscilloscope on Negative Reference, Pin K2B04.

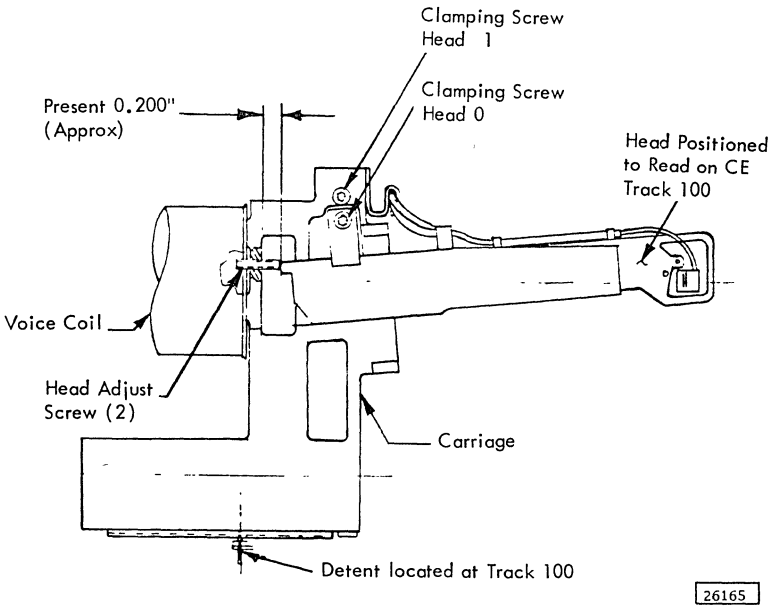


Figure 7-7. Head Arm Assembly Adjustment

7. Insert the Head Alignment Oscilloscope Adapter (P/N 2200052) between the head cable plug and socket for head 0. Select head 0 with the CE Head Select switch.
8. Slowly advance the head adjusting screw while observing the scope pattern. The scope will first show noise only, then the pattern of View A, Figure 4-8 will appear. When the head is properly aligned, the pattern of View B, Figure 4-8 will be present and the lobes will be equal in amplitude.

NOTE: If the head is moved forward, too far toward the spindle, it will be necessary to shut down the machine, remove the CE cartridge, and push the arm backwards toward the voice coil as described in step 3, then repeat step 8. When the head-arm assembly is correctly positioned, the lip of the head load spring will bear on the dimple of the arm assembly spring. The head load spring will not be in contact with the plotted capsule which encases the read/write coils. It will be necessary to shift the detent rack slightly if correct adjustment cannot be made using step 8.

9. Back off the head adjusting screw one-half turn when adjustment has been completed. Observe the scope display pattern to ensure that the head alignment is not affected.
10. Use the CE switch to select Head 1, and repeat steps 2 through 9.

NOTE: If the detent rack was moved to accomplish adjustment of the head-arm assemblies, it will be necessary to readjust the crash stops (section 4.10), home switch (section 7.11), and tachometer extension rod (section 7.12.2).

11. Replace drive magnet on the actuator (section 7.6.1) and connect head cables, plugs, and sockets.

7.16 CARTRIDGE RECEIVER

7.16.1 Cartridge Receiver Removal and Replacement (Figure 7-8)

1. Remove all ac and dc power from the machine.
2. Remove tension spring that attaches to cartridge receiver and interlock assembly.
3. Remove both cartridge receiver support-pivot brackets from baseplate.

WARNING: Exercise care in lifting the cartridge receiver from machine to avoid striking the detent assembly and disrupting the detent adjustment.

4. Lift cartridge receiver from machine.
5. Replace the cartridge receiver by reversing steps 2 through 4.
6. Check the cartridge receiver adjustments described in section 7.16.2. Readjust only if absolutely necessary.

7.16.2 Cartridge Receiver Adjustment

NOTE: The cartridge receiver adjustment must be completed prior to attempting an adjustment of the cartridge interlocks. Any cartridge serves as a gage for adjusting the side-to-side position of the cartridge receiver. After this adjustment is made, it should not be changed unless trouble is suspected. Adjustment is to be accomplished as follows:

1. Loosen both self locking nuts located on the pivots of the cartridge receiver so that receiver is free to move slightly in a sidewise direction (Figure 7-8).

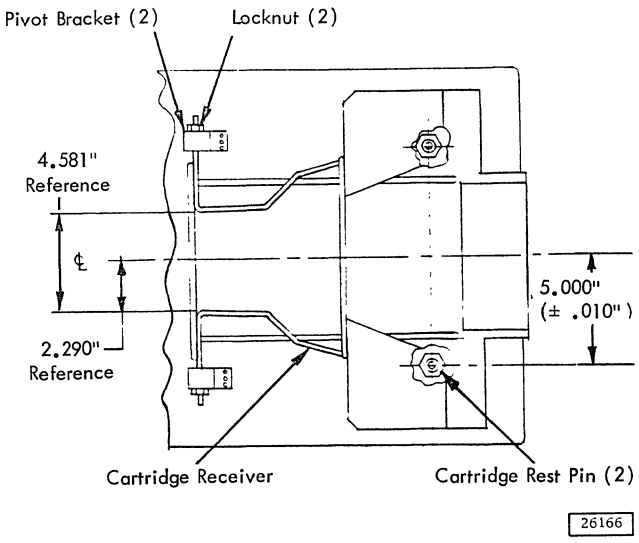


Figure 7-8. Cartridge Receiver Adjustment

2. Install a cartridge and check for clearance on each side. If there is a gap between the front of the top rails of the receiver and the matching raised portion of the front top of the cartridge (near the door), take up this clearance equally on both sides using IBM cards as shims.
3. Shake the front of the cartridge receiver sideways until it assumes its preferred position.
4. With the front of the cartridge receiver located in its preferred position, tighten the two self locking nuts until they just contact surfaces of the cartridge receiver pivot brackets. This will secure the adjustment.

NOTE: With this adjustment established, the cartridge receiver and receiver pivot brackets should always be removed and replaced as an assembly without disturbing the adjustment of the self locking nuts.

7.17 INTERLOCKS

7.17.1 Handle and Interlock Adjustment (Figure 4-10)

NOTE: The cartridge receiver adjustments (section 7.16.2) must be completed prior to attempting an adjustment of the cartridge interlocks.

Handle Stop Screw (View A, Figure 4-10)

The Handle stop screw must be adjusted so that when a cartridge is in place, the handle risers will have clearance with the outer edge (vertical-cylindrical surface) of the cartridge.

Adjustment of the handle stop screw is accomplished as follows:

1. Install CE Cartridge in machine.
2. Loosen handle stop screw locknut.
3. Adjust the handle stop screw so that handle risers are parallel with, and clear the outer edge of the cartridge by 0.060 (±0.030) inch.
4. Secure locknut on handle stop screw after this adjustment is obtained.

NOTE: At discretion of the CE, the interlock handle and bracket assembly may be removed to accomplish the next several adjustments. Remove the two flathead screws which secure bracket to the baseplate. Remove wire connections at pins 3 and 4 from terminal block (TB6). Mark each pin location to facilitate reassembly.

Latch Screw Clearance Adjustment (View B, Figure 4-10)

1. Fully rotate handle to the Cartridge In Place position.
2. Adjust the interlock latch screw so that it will seat into the square-hole notch of the latch.
3. Determine that 0.040 (±0.010)-inch overtravel latching clearance exists between the flat surface of the screw and upper edge of notch on the latch. Adjust latch screw as necessary to obtain this clearance.
4. Tighten locknut on latch screw after adjustment has been made.

Latch Switch Adjustment

Adjustment of latch switch is the same as section 4.19.1.

Interlock Magnet Adjustment

Adjustment of the interlock magnet is the same as section 4.19.1.

7.18 SECTOR TRANSDUCER

7.18.1 Sector Transducer Index Timing Adjustment (Figure 7-9)

1. Remove CPU signal cable from machine.
2. Install CE Cartridge.
3. Power up machine so that heads will load.
4. Using CE panel, access carriage to track 095.
5. Using CE oscilloscope, read track 095 by scoping pin D3B07. Synchronize the negative reference on pin K2B04.
6. Observe the time delay from reference pulse to the peak of the timing pulse on track 095. The delay from the leading edge of the reference pulse to the timing pulse should be 30 (±5)μs.

NOTE: The timing pulse precedes the burst of the all bits pattern by 10μs.

7. Determine the magnitude and direction (+ or -) of the correction to be made in pulse timing so that a time delay of 30 (±5)μs will prevail for both read/write heads.
8. Power down machine and remove CE cartridge.

9. With the cartridge handle in the open position, loosen the transducer lock screw (Figure 7-9).
10. Use the transducer adjusting screw (Figure 7-9) to position the transducer to increase or decrease the time delay. Turn the screw clockwise to increase the time delay and counterclockwise to decrease the time delay. One turn of the adjusting screw provides a change in time delay of 78μs.
11. Install the CE cartridge, power up machine and observe the scope pattern (Figure 4-11) to verify that timing adjustment is within limit of 30 (±5)μs.

NOTE: Some jitter will be experienced in making this adjustment. The mean timing pulse position is to be used as a reference setting.

12. Power down the machine, remove the CE cartridge and tighten the transducer lock screw to secure the adjustment.
13. Repeat steps 1 through 7 to check the adjustment and readjust according to setps 8 through 10 if required.

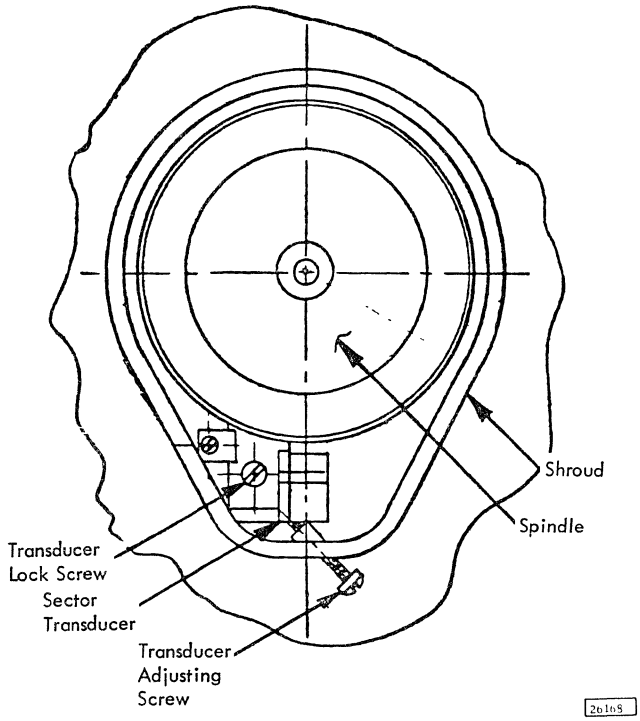


Figure 7-9. Index Timing Adjustment

ALPHABETICAL INDEX

The alphabetical index includes references for alternate maintenance procedures applicable for machines with serial numbers from 00001 through 00050. Each index item listed which is affected by the design differences described in Chapter 7, is indicated by a reference to the appropriate section number of Chapter 7.

AC input supply power, 5.1
Access circuit malfunction troubleshooting, 1.4
Access adjustments, 4.5
Access malfunctions, 1.4
Actuator assembly, 4.5, 7.3
Actuator assembly removal and replacement, 4.5, 73.
Alternate maintenance features, 7.1
Approach to scheduled preventive maintenance, 3.1

Base plate component malfunctions, 1.6
Blower assembly, 4.4, 7.3
Blower assembly removal, 7.3
Blower assembly removal and replacement, 4.4
Blower motor removal and replacement, 4.5, 7.3
Blower Scroll removal and replacement, 4.5
Blower wheel removal and replacement, 4.4
Branch office tools, 2.3, 7.1

Carriage rail, 4.16, 7.11
Carriage preload bearing assembly, 4.16
Carriage preload bearing assembly removal and replacement, 4.16
Carriage rail removal and replacement, 4.16, 7.11
Carriage subassembly, 4.16, 7.11
Carriage subassembly removal and replacement, 4.16, 7.11
Cartridge assembly, 4.2
Cartridge in place switch adjustment, 4.20
Cartridge receiver, 4.9, 7.13
Cartridge receiver adjustment, 4.19, 7.13
Cartridge receiver removal and replacement, 4.19, 7.13
Cartridge service check, 4.2
CE control panel, 2.1
CE switches, 2.1
Cleanliness, 3.1
Cleaning read/write heads, 3.1
Crash stops, 4.14, 7.9

Data separator, 4.24
Data separator adjustment, 4.24
Detent assembly adjustment, 4.10, 7.4
Detent assembly and detent rack, 4.10, 7.4
Detent rack adjustment, 4.12, 7.6
Detent assembly and rack troubleshooting, 1.4
Detent assembly removal and replacement, 4.10, 7.4
Detent rack removal and replacement, 4.10, 7.5
Diagnostic aids, 1.1
Diagnostic techniques, 1.1
Direction switch, 2.2
Disk cartridge and read/write damage, 3.4
Disk cartridge replacement conditons, 4.4
Disk formatting procedure, 1.6
Disk height and run out check, 4.3
Drive belt removal and replacement, 4.2
Drive belt tension adjustment, 3.4
Drive coil removal and replacement, 4.10
Drive magnet, 7.3
Drive magnet and coil, 4.9
Drive magnet removal and replacement, 4.9, 7.3
Drive motor and drive belt, 4.2
Drive motor removal and replacement, 4.2

Electronic circuits, 3.1
Errors and data retrieval, 1.7
Error retry procedure, 1.7

Front crash stop adjustment, 4.14
Functional check, 1.1

General, 6.1

Handle and interlock adjustment, 4.20, 7.15
Head and disk cartridge scratch description, 3.4
Head-arm assembly, 4.17, 7.12
Head arm assembly adjustment, 4.17, 7.12
Head arm assembly removal and replacement, 4.17
Head load assembly, 4.12, 7.6
Head load assembly adjustment, 4.12
Head load solenoid removal and replacement, 4.12
Head select switch, 2.1
Head load spring assembly, 4.14, 7.9
Head load spring assembly removal and replacement, 4.14
Heads loaded switch removal, replacement, and adjustment, 4.14
Home switch, 4.14, 7.9
Home switch adjustment, 4.14, 7.9
Home switch removal and replacement, 4.14, 7.9
Homing the carriage, 1.7

Identification of machines, 7.1
Index of service checks, adjustments and removals, 4.1
Input power lines to disk storage drive, 5.1
Interlocks, 4.20, 7.15

Leading particulars, 2.1
Locations, 6.1
Lubrication of machine, 3.1

Mainenance features, 2.1
Mechanical units, 3.1

Non particle damage, 3.4

Particle damage to disk, 3.4
Particle damage to head, 3.4
Plenum cover and filter, 7.1
Plenum air filter removal and replacement, 7.1
Plenum cover removal and replacement, 7.1
Power line interference, 5.1
Power off sequence, 5.1
Power on sequence, 5.1
Power requirements, 5.1
Power sequencing, 5.1
Purpose of supplement, 7.1
Power supply, 5.1

Read malfunctions, 1.1
Read circuit troubleshooting, 1.1
Read/write heads, 4.17
Read/write head replacement, 4.17
Read/write head service check, 4.17
Read/write head to base plate resistance check, 4.17

Scheduled maintenance procedures, 3.1
Scheduled preventive maintenance procedures, 3.1
Sector transducer, 4.22
Sector transducer index timing adjustment, 4.22
Sector transducer removal and replacement, 4.24
Service aids, 1.6
Service checks, adjustment, and removal procedures, 4.1
Standard tools, 2.3
Step control switch, 2.2
Special tools, 2.3, 7.1
Spindle assembly removal and replacement, 4.2
Supplement for alternate maintenance instructions, 7.6

Tachometer and tachometer extension rod, 4.14, 7.10
Tachometer assembly removal and replacement, 4.15, 7.11
Tachometer extension rod adjustment, 4.15, 7.10
Tachometer extension rod removal and replacement, 4.14
Tachometer extension rod removal, 7.10
Tools and test equipment, 2.3
Track addressing, 1.6
Troubleshooting base plate components, 1.6

Visual inspection, 3.1, 4.3

Write circuit troubleshooting, 1.2
Write malfunctions, 1.2

CUT ALONG LINE

READER'S COMMENT FORM

FROM:

NAME _____ DATE _____

OFFICE/DEPT. _____

CHECK ONE OR MORE OF THE COMMENT BLOCKS AND EXPLAIN IN THE SPACE PROVIDED.

☐ ADDITION: PAGE(S) FIGURE(S)

☐ DELETION: PAGE(S) FIGURE(S)

☐ ALTERATION: PAGE(S) FIGURE(S)

FOLD FOL

EXPLANATION:

FOLD FOLD

NO POSTAGE NECESSARY
IF MAILED IN U.S.A.

FOLD ON TWO LINES,
STAPLE, AND MAIL

2310 Disk Storage

Form No. 227-5984-1

STAPLE

STAPLE

)LD

FIRST CLASS
PERMIT NO. 2078
SAN JOSE, CALIF.

BUSINESS REPLY MAIL
NO POSTAGE STAMP NECESSARY IF MAILED IN U. S. A.

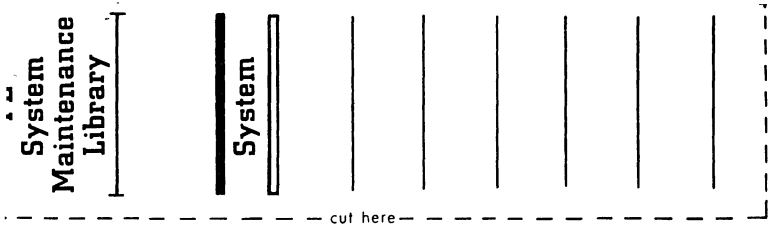
POSTAGE WILL BE PAID BY

IBM CORPORATION
MONTEREY & COTTLE RDS.
SAN JOSE, CALIFORNIA
95114

ATTN: PRODUCT PUBLICATIONS DEPT. 455

CUT ALONG LINE

)LD



227-5984-1

IBM 2310 Printed in U.S.A. 227-5984-1

IBM®
International Business Machines Corporation
Field Engineering Division
112 East Post Road, White Plains, N.Y. 10601