IBM Field Engineering

Theory-Maintenance

5444 Disk Storage Drive

(Machines with serial no. up to 30100)

SY33-0026-0

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Preface

This manual provides, for the customer engineer, instructional information on the IBM 5444 Disk Storage Drive. Part 1 (pages prefixed 1-) of the manual describes the theory of operation of the machine, Part 2 (pages prefixed 2-) gives its maintenance, and appendixes contain reference data. The manual does not, however, contain information on control circuits and power supplies that are located outside the machine. A glossary of special terms and an index are provided.

For maintenance of the machine, it is assumed that the reader has had theoretical and practical training on the 5444 Disk Storage Drive and that he is familiar with the using system to which the 5444 is attached. It is also assumed that he is familiar with the use of CE tools and with the servicing techniques that are employed in the maintenance of IBM equipment.

Associated Publications

The following documentation is associated with this manual:

1. The manuals of the using system to which the 5444 is attached.
2. Automated logic diagrams and other engineering – controlled documents for the 5444. These are referred to in the manual and are shipped with each machine.
3. Installation instructions for the 5444. These are also shipped with each machine.
4. Symptom indexes and service aids for the 5444. These are distributed by technical operations departments as the need arises and are available from IBM branch offices.
5. IBM Illustrated Parts Catalog *5444 Disk Storage Drive (Machines with serial no. up to 30,100),* Order No. S135-0001.

Abbreviations

AC,ac	Alternating Current
ALD	Automated Logic Diagram
C	Common
CE	Customer Engineer
cm	Centimeter
DC,dc	Direct Current
EC	Edge Connector
EMF	Electromotive Force
HDI	Head-to-Disk-Interference
hp	Horsepower
Hz	Hertz
in.	Inch
MAP	Maintenance Analysis Procedure
mm	Millimeter
ms	Millisecond
NC	Normally Closed
NO	Normally Open
NRZ	Non-Return to Zero
ns	Nanosecond
Rd	Read
R/W	Read/Write
SLD	Solid Logic (Dense)
SLT	Solid Logic Technology
TAP	Tuning Analysis Program
TB	Terminal Block
μs	Microsecond
V	Volt

Second Edition (July, 1970)

This is a major revision of, and obsoletes ZZ33-0026-0. Changes are continually made to the information herein; any such changes will be reported in subsequent revisions or FE Supplements.

A form for readers' comments is provided at the back of this publication. If the form has been removed, comments may be addressed to IBM United Kingdom Laboratories Ltd., Product Publications, Hursley Park, Winchester, Hants, England.

Part 1. Theory

Part 2. Maintenance

Appendixes and Index

Part 1. Theory

Maintenance

Appendixes

Note: The illustrations in this manual have a code number adjacent to the caption. This is a publishing control number and is unrelated to the subject matter.

PERSONAL SAFETY

Safety cannot be over-emphasized. To ensure personal safety and that of co-workers, follow safety precautions at all times.

General Safety Practices

Become familiar with the general safety practices and the procedures for artificial respiration that are outlined in *CE Safety Practices Card,* Order No. S229-1264. This card is issued to all customer engineers and is also obtainable from IBM Distribution Center, East Simpson Ferry Road, Mechanicsburg, Pennsylvania 17055, U.S.A.

Safety Practices at the 5444

AC and DC Power: AC power and dc power are present at terminals inside the machine while the using system remains powered up. Therefore, always turn off power *before* working on the machine.

Drive Disk and Drive Tire: Do not clean the drive disk or drive tire while the machine is running.

Drive Motor: The motor is provided with a thermal cutout that restores power when the motor has cooled after overheating. Always turn off power, therefore, before working on the motor.

Isopropyl Alcohol: Use only IBM part 2200200 for cleaning parts as specified in Part 2. *Isopropyl alcohol is a flammable liquid;* therefore observe strict precautions regarding its storage. Keep only the minimum quantity that is needed for immediate use, and store it in the original container whenever possible. Note the shipping regulations that are given on the container.

Equipment Safety

The machine can be easily damaged by incorrect operation and wrong servicing techniques. Cautionary notes are inserted in the text of Part 2 and are summarized here.

Cartridge Removal: Before removing a cartridge during a fault condition, make sure that the carriage and cleaning brushes are fully retracted.

CE SAFETY PRACTICES

All Customer Engineers are expected to take every safety precaution possible and observe the following safety practices while maintaining IBM equipment:

1. You should not work alone under hazardous conditions or around equipment with dangerous voltage. Always advise your manager if you MUST work alone.
2. Remove all power AC and DC when removing or assembling major components, working in immediate area of power supplies, performing mechanical inspection of power supplies and installing changes in machine circuitry.
3. Wall box power switch when turned off should be locked or tagged in off position. "Do not Operate" tags, form 229-1266, affixed when applicable. Pull power supply cord whenever possible.
4. When it is absolutely necessary to work on equipment having exposed operating mechanical parts or exposed live electrical circuitry anywhere in the machine, the following precautions must be followed:
   a. Another person familiar with power off controls must be in immediate vicinity.
   b. Rings, wrist watches, chains, bracelets, metal cuff links, shall not be worn.
   c. Only insulated pliers and screwdrivers shall be used.
   d. Keep one hand in pocket.
   e. When using test instruments be certain controls are set correctly and proper capacity, insulated probes are used.
   f. Avoid contacting ground potential (metal floor strips, machine frames, etc. — use suitable rubber mats purchased locally if necessary).
5. Safety Glasses must be worn when:
   a. Using a hammer to drive pins, riveting, staking, etc.
   b. Power hand drilling, reaming, grinding, etc.
   c. Using spring hooks, attaching springs.
   d. Soldering, wire cutting, removing steel bands.
   e. Parts cleaning, using solvents, sprays, cleaners, chemicals, etc.
   f. All other conditions that may be hazardous to your eyes. REMEMBER, THEY ARE YOUR EYES.
6. Special safety instructions such as handling Cathode Ray Tubes and extreme high voltages, must be followed as outlined in CEM's and Safety Section of the Maintenance Manuals.
7. Do not use solvents, chemicals, greases or oils that have not been approved by IBM.
8. Avoid using tools or test equipment that have not been approved by IBM.
9. Replace worn or broken tools and test equipment.
10. Lift by standing or pushing up with stronger leg muscles — this takes strain off back muscles. Do not lift any equipment or parts weighing over 60 pounds (27,2 kilogrammes).
11. All safety devices such as guards, shields, signs, ground wires, etc. shall be restored after maintenance.
12. Each Customer Engineer is responsible to be certain that no action on his part renders product unsafe or exposes hazards to customer personnel.
13. Place removed machine covers in a safe out-of-the-way place where no one can trip over them.
14. All machine covers must be in place before machine is returned to customer.
15. Always place CE tool kit away from walk areas where no one can trip over it (i.e., under desk or table).
16. Avoid touching mechanical moving parts (i.e., when lubricating, checking for play, etc.).
17. When using stroboscope — do not touch ANYTHING — it may be moving.
18. Avoid wearing loose clothing that may be caught in machinery. Shirt sleeves must be left buttoned or rolled above the elbow.
19. Ties must be tucked in shirt or have a tie clasp (preferably nonconductive) approximately 3 inches from end. Tie chains are not recommended.
20. Before starting equipment, make certain fellow CE's and customer personnel are not in a hazardous position.
21. Maintain good housekeeping in area of machines while performing and after completing maintenance.

KNOWING SAFETY RULES IS NOT ENOUGH
AN UNSAFE ACT WILL INEVITABLY LEAD TO AN ACCIDENT
USE GOOD JUDGMENT — ELIMINATE UNSAFE ACTS

229-1264-1

Artificial Respiration

GENERAL CONSIDERATIONS

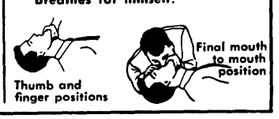
1. **Start Immediately, Seconds Count**
   Do not move victim unless absolutely necessary to remove from danger. Do not wait or look for help or stop to loosen clothing, warm the victim or apply stimulants.
2. **Check Mouth for Obstructions**
   Remove foreign objects — Pull tongue forward.
3. **Loosen Clothing — Keep Warm**
   Take care of these items after victim is breathing by himself or when help is available.
4. **Remain in Position**
   After victim revives, be ready to resume respiration if necessary.
5. **Call a Doctor**
   Have someone summon medical aid.
6. **Don't Give Up**
   Continue without interruption until victim is breathing without help or is certainly dead.

Reprint Courtesy Mine Safety Appliances Co.

Rescue Breathing for Adults Victim on His Back Immediately

1. **Clear throat** of water, food, or foreign matter.
2. **Tilt head back** to open air passage.
3. **Lift jaw up** to keep tongue out of air passage.
4. **Pinch nostrils** to prevent air leakage when you blow.
5. **Blow** until you see chest rise.
6. **Remove your lips** and allow lungs to empty.
7. **Listen** for snoring and gurglings, signs of throat obstruction.
8. **Repeat mouth to mouth breathings** 10-20 times a minute.

Continue rescue breathing until he breathes for himself.



CE Safety Practices Card, Form 229-1264

CE Cartridge – Restricted Tracks: Do not overwrite tracks 004,005,006, and 071 through 075. These are prewritten tracks for use during alignment and, once destroyed, must be factory recreated.

Cleanliness: In the 5444, cleanliness is of the utmost importance. Because the read/write heads fly clear of the disk surface by only 85 millionths of an inch, extremely small particles can be trapped in this gap; these particles can accumulate until they damage the disk surfaces or the head faces. When the machine is being worked on with the top cover removed, take care not to let tools or other equipment fall inside the machine.

Contamination of Other 5444's: If a head-to-disk interference occurs on a disk cartridge, particles may be generated that can damage other 5444's if the defective cartridge is placed on them. *If a disk cartridge is damaged, it must never be used on another 5444.*

Disk Damage: The coated surfaces of the disks must be protected from any damage. When installing a read/write head, first wrap a lint-free tissue, IBM part 2162567, around the head to prevent a head-to-disk contact. When removing or replacing an actuator assembly, take careful note of the cautions given under the item 4.4 in Part 2, so that the disk will not be damaged. The actuator assembly must stay in contact with the base and not be allowed to lift during the course of adjustment.

Inner Limit Stop Shaft: The setting of the inner limit stop shaft provides a reference position for the drive disk. Therefore, loosen *either* the inner limit stop shaft *or* the drive disk (but not both parts) at any one time.

Power Sequencing: Do not apply 24V dc without also applying other logic voltages; otherwise, the voice coil will be damaged.

Precision Components: All components contributing to the accuracy of the actuator and carriage must be handled and stored with extreme care. In particular, the leadscrew, follower, and ball slides must be kept free from contamination or damage. Head arm assemblies should be stored in transit boxes.

Read/Write Heads: Do not touch the faces of the read/write heads with your fingers, because skin oil can attract particles and erode the head. Do not blow on the heads because saliva can damage similarly.

SLT Cards: Remove power before removing or replacing a card, to prevent damage to other cards in the circuit.

Part 1. Theory

MACHINE DESCRIPTION

- **The IBM 5444 Disk Storage Drive is a direct-access storage unit providing up to 40 million bits of data storage.**
- **Three models are available.**
- **Data is stored on both sides of magnetic recording disks.**
- **A removable upper disk forms part of the IBM 5440 Disk Cartridge.**
- **Machine operations of accessing, reading, and writing are controlled from the using system.**
- **Read and write operations are accomplished using read/write (R/W) heads.**
- **An actuator carries the read/write heads over the disk surfaces.**

The 5444 Disk Storage Drive (Figure 1-1) is a direct-access disk file that provides auxiliary storage for small computer systems. The unit is designed to be mounted within the frame of the using system.

The storage medium is a 14 in. (356 mm) diameter disk, coated on both sides with magnetic iron oxide. The 5444 can accommodate two such disks mounted on a common drive spindle. The lower disk is permanently mounted in an enclosure at the base of the drive spindle. The top disk forms part of the 5440 Disk Cartridge and is removable.

Data is stored in concentric tracks on the recording surfaces. To replace any defective tracks, three extra tracks on each surface can be used. One further extra track per surface is available for use only by the customer engineer (CE).

Three models of the 5444 are available, the main differences being the storage capacity and number of disks used.

Differences between Models

Model 2 is described in this manual; any differences between models are dealt with where appropriate.

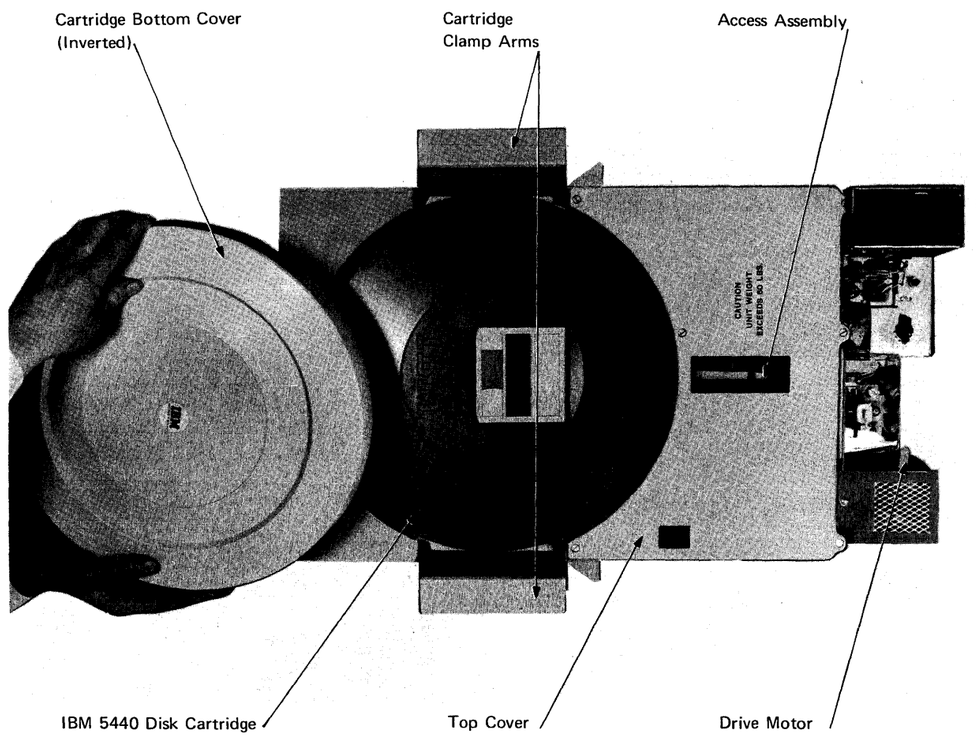


Figure 1-1. IBM 5444 Disk Storage Drive [07461]

Model 1: Two disks. Data is stored on both disks, on 100 tracks of each of the four recording surfaces. The total storage capacity is 20 million bits.

Model 2: Two disks. Data is stored on both disks, on 200 tracks of each of the four recording surfaces. The total storage capacity is 40 million bits.

Model 3: One disk (removable) only. Data is stored on 200 tracks on each recording surface of this disk. The total storage capacity is 20 million bits.

Major Units

- **The major units are described in detail in Chapter 2.**

The 5444 contains two 14 in. (356 mm) magnetic recording disks on a common drive spindle. The lower disk is fixed and the upper disk removable forming part of the IBM 5440 Disk Cartridge. Writing and reading uses four read/write heads: one for each recording surface. The four heads are supported in a carriage that moves on linear ball slides within the actuator frame.

Movement of the carriage is from a leadscrew driven via a flexible drive disk which, in turn, obtains its motion from a constantly-turning layshaft. Forward or reverse motion of the carriage is given by clutches acting on the flexible drive disk. The heads are stopped at the correct track by a detent on the leadscrew. A drive motor rotates the disks and the layshaft.

The upper removable disk (the only disk on Model 3) is permanently enclosed in the 5440 Disk Cartridge. The cartridge may be easily removed from the 5444 and can be fitted to other cartridges and 5444's. Cartridge interchangeability depends on model. Model 1 reads only the first 100 tracks of a disk and so reads only *part* of a disk written on a Model 2 or 3.

MACHINE SAFETY AND DATA PROTECTION

Safety devices on the 5444 control start/stop sequencing and actuator operations and protect recorded data. The safety devices include drawer and cartridge interlocks to prevent access during operation, and interlocks to prevent the 5444 starting when the 5444 is open. The CE can override the interlocks during maintenance.

The 5444 includes sensors to monitor the write circuits during read/write operations. If an unsafe condition occurs, a 'data unsafe' signal is sent to the using system to inhibit all further read/write operations until the cause of the unsafe condition is removed.

MACHINE OPERATIONS

- **All machine operations are controlled by signals from the using system.**

Start/Stop Sequence

- **Start and stop sequences are controlled by a '+24V file start' line from the using system.**

Before the start-up sequence commences, the using system power supplies must be switched on, and the drawer and cartridge interlocks made. Start-up sequence commences with line '+24V file start' activated, and

takes approximately one minute to complete. During this time, four cleaning brushes sweep across the disk recording surfaces to remove dust particles. The one minute sequence also allows the machine electronics and the temperature in the disk enclosure to stabilize.

At the end of the start-up sequence, the disks are spinning at 1500 rpm with the read/write heads loaded over the disks at track 000. A 'ready' signal indicates to the using system that the 5444 can start operations.

Stop sequence commences when '+24V file start' drops. The read/write heads unload and retract off the disks. When the disks have stopped, the 5444 can be opened to remove the disk cartridge.

Note: When '+24V file start' is dropped, all dc power supplies remain on at the machine and ac power is still present in the ac box.

Carriage Movement

- **Controlled by 'access forward' and 'access reverse' lines from the using system.**

The 5444 must be ready before a carriage movement can begin. While the read/write heads are moving over the tracks on the disk, the 5444 generates 'track crossing' pulses to enable the using system to determine the head position.

When 'access forward' or 'access reverse' is activated, the carriage moves the heads across the disk surfaces. When the access command is dropped, a detent mechanism engages and stops the carriage, leaving the read/write heads positioned over the required track.

Read/Write Operations

- **Read/write operations are controlled by 'read select', 'write select', and 'erase select' lines from the using system.**

To perform a read or write operation, the appropriate head is defined by 'head select' and 'disk select' lines. The read or write is further defined by 'read select' or 'write select' and 'erase select' lines respectively from the using system.

The erase coil is always energized during a write operation to trim the edges of the written data tracks. This technique is called 'side erase'.

Manual Control of the 5444

The 5444 may be controlled manually from a CE control panel. Two switches on this panel enable the 5444 to be switched off-line to give manual selection of any head or track. When controlled from the CE control panel, the 5444 is write-inhibited.

Machine Control from the Using System

The 5444 is under the complete control of the using system for accessing, reading, and writing. The 5444 contains access control logic, read/write logic, and safety and interlock circuits. Twelve input and eight output lines form an interface with the using system. The interface is described in Chapter 3.

DATA ORGANIZATION

- **Track format is determined by the using system.**
- **Where a byte is referred to, an 8-bit byte is implied.**

Cylinder

The 5444 contains two disks, totalling four surfaces for recording. (Model 3 has one disk, giving two recording surfaces.) Each disk consists of 203 concentric cylinders. (Model 1 consists of 103 cylinders.) Each cylinder has two tracks, one on the top surface, and one on the bottom surface. At each cylinder address, either track may be read (or written onto) by selecting the appropriate read/write head.

Alternate Cylinder Assignment

Model 1 has 103 cylinders, Models 2 and 3 have 203 cylinders. On all models, three of these cylinders are used as alternate cylinders where data is transferred to replace a defective cylinder. The alternate cylinders are numbered 001, 002, 003 (on all models).

CE Cylinder

One extra cylinder on each disk (Model 1: cylinder 103; Models 2 and 3: cylinder 203) is reserved for CE use during maintenance.

Track Format

- **Each track is divided into 24 sectors.**
- **An index marker pulse indicates the start of each track.**

The track format is shown in Figure 1-2. Each track is divided into 24 equal length sectors. A data record is identified by specifying the cylinder, head, and sector number corresponding to that record.

An index marker pulse indicates the start of each track and aligns all tracks on any disk. The index pulses are derived from index transducers monitoring rotation of the two disks. The upper removable disk and the fixed disk have separate index transducers.

After the index pulse, there is a gap of 32 bytes before the first sector is written. This gap allows for variation in the position of the index pulse.

Sector Format

- **Each sector contains an identifier field and a data field.**
- **Address marks denote the beginning of each sector.**

The sector format is shown in Figure 1-3. The beginning of each sector is denoted by address marks which are derived from the 'read data' output of the read amplifier. A data separator in the using system separates 'read data' into data pulses and clock pulses. The data separator also provides address marks indicated by missing clock pulses.

The identifier field contains a flag byte, two address bytes, and three check bytes. The flag byte indicates either that the entire track is not used because of some defect, or that the track is an alternate track replacing a defective track. The two address bytes contain the sector address as a 14-bit binary number. The three check bytes are generated by the using system to verify the identifier field.

The data field contains one synchronizing byte from the using system, 256 data bytes, and three check bytes.

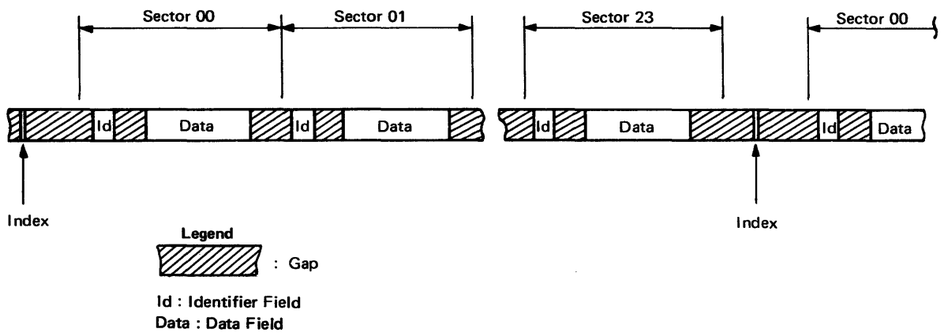


Figure 1-2. Track Format [07462]

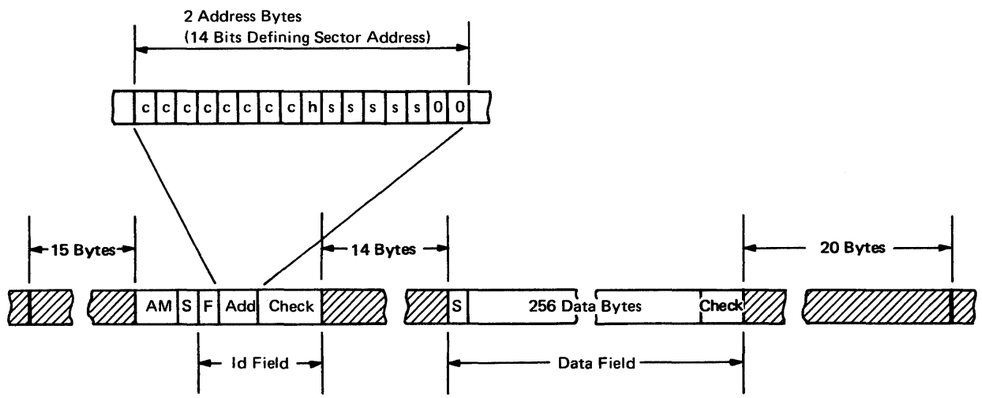


Figure 1-3. Sector Format [07463]

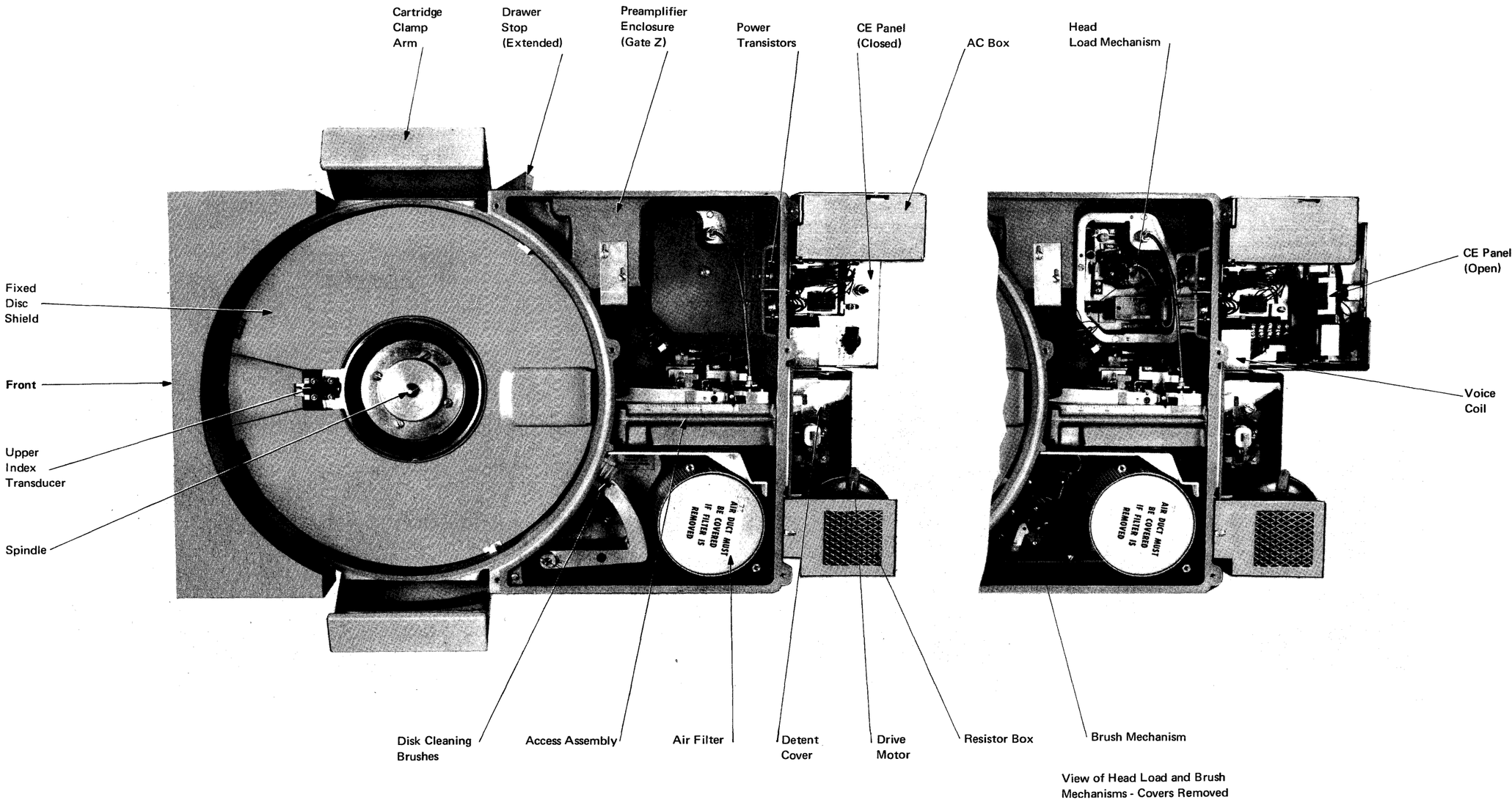


Figure 1-4. Component Layout – Top View [07464]

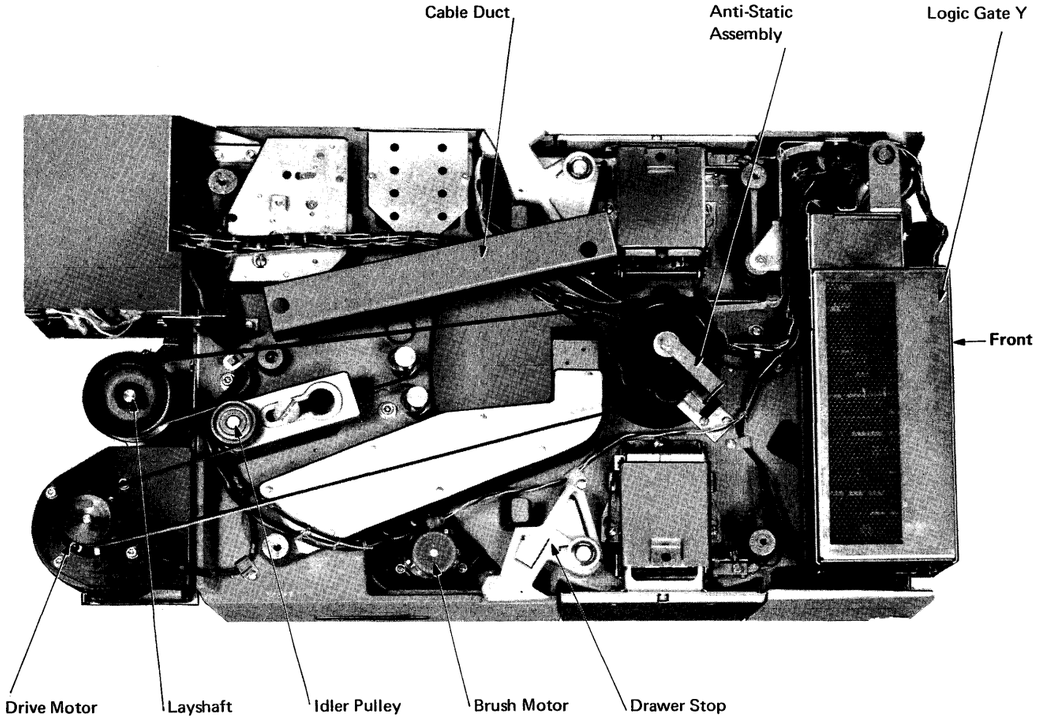


Figure 1-5. Component Layout – Underside View [07465]

BASE

The component parts of the 5444 are mounted on a cast light-alloy base. A closed air-circulation system is built into the casting. Figures 1-4 and 1-5 show the layout of the component parts on the base casting.

The using system provides mounting facilities for the 5444 (see Appendix C).

AIR-CIRCULATION SYSTEM

- **A closed air-circulation system keeps the disk chamber free from contamination. An air filter removes dust particles.**
- **Impeller blades on the rotating lower disk hub assist the flow of air.**

The read/write heads fly close to the disk surface. Contamination is therefore removed from the air in the disk chamber to avoid head-to-disk interference. A closed air-circulation system (Figure 1-6) maintains a contamination-free environment for the disks.

An air filter removes any dust particles down to 1/3 micron in diameter. The air then recirculates into the disk chamber via a duct in the base. The disk cleaning brushes park within the airstream.

Eight impeller blades on the underside of the lower disk hub assembly force air through the filter and back through the return duct to the center of the disk chamber. A deflector plate ensures a streamline airflow through the filter and prevents dust particles in the brush area from re-entering the disk chamber.

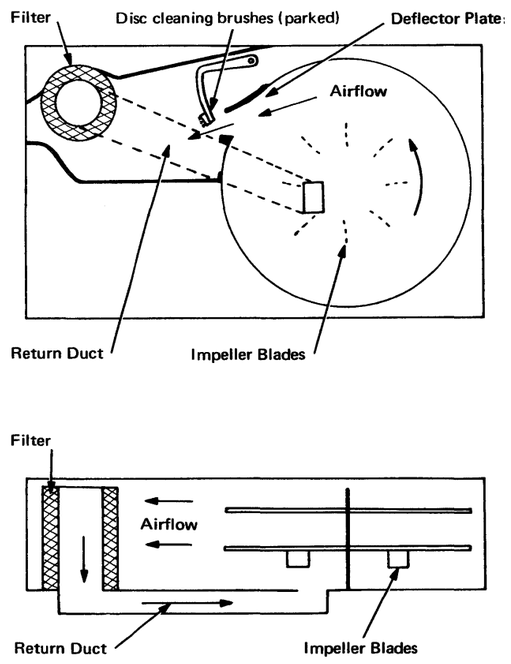


Figure 1-6. Air-Circulation System [07466]

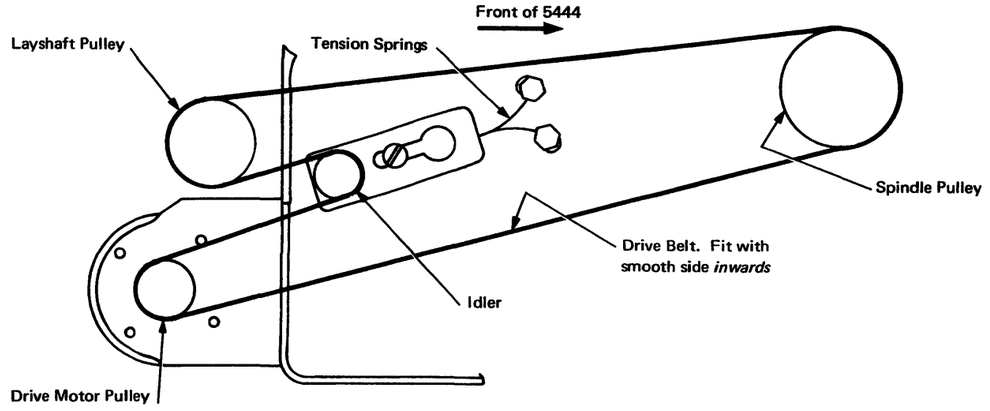


Figure 1-7. Motor Drive Schematic [07467]

DRIVE MECHANISM

- **The disks rotate at 1500 rev/min.**
- **A layshaft pulley incorporated in the drive mechanism provides motive power for the actuator assembly.**
- **Drive belt tension is automatically set by a spring-loaded idler pulley.**

The disks on the drive spindle (one only on the Model 3) are driven at 1500 rev/min by a 1/12 hp motor via a flat drive belt and an idler pulley (Figure 1-7). The drive belt is coupled via a layshaft pulley to the actuator assembly, which moves the read/write heads over the recording surfaces of the disks. The idler pulley maintains tension on the drive belt.

Drive Motor

- **Different drive motors and pulleys are used for 50 Hz and 60 Hz operation (see Appendix B).**

The drive motor is a 1/12 hp capacitor induction motor and is fixed to the base on a moulded plastic mounting to ensure that the motor is electrically insulated from the base.

A thermal cutout integral with the motor body cuts off the motor ac supply to protect the motor from overheating; operation of the cutout shuts down the 5444. The cutout resets automatically when the motor cools down. Normal machine start-up procedure may then be performed provided that the cause of thermal trip is rectified.

To enable the 5444 to be operated from 50 Hz and 60 Hz power supplies, different drive motors and motor pulleys are available (see Appendix B).

DC Braking

DC braking ensures that the disks stop rotating within 30 seconds during a file-stop-sequence. When '+24V file start' is dropped, relay K5 is energized to pass dc through the drive motor. K5 is de-energized when 'speed zero' is activated near the end of the file-stop-sequence.

Anti-Static Brush

A carbon bearing on the anti-static brush runs against the domed base of the drive spindle and grounds the spindle to the base (that is, logic ground).

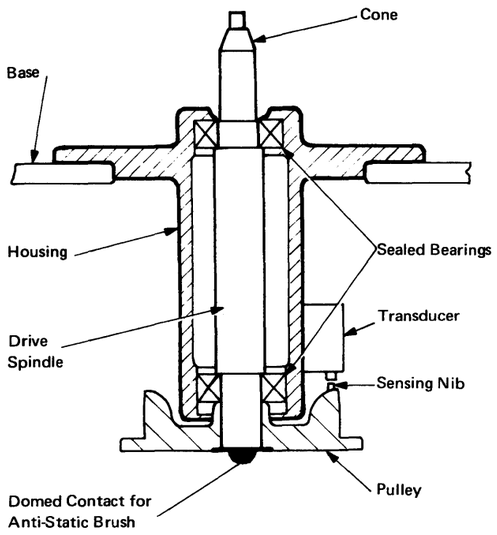


Figure 1-8. Drive Spindle [07468]

DRIVE SPINDLE

The drive spindle (Figure 1-8), which carries the two recording disks, runs in two sealed bearings within a housing bolted to the base. Drive is obtained from the drive motor via a belt and a pulley mounted on the spindle.

A metal nib fixed to the pulley is sensed by a transducer, which provides an index pulse to indicate the start of each recording track on the permanent (lower) disk.

RECORDING DISKS

- **Each disk has coated surfaces which can be magnetized to store bit patterns.**
- **Models 1 and 2 use two disks.**
- **Model 3 uses one disk.**
- **Model 1 uses only tracks 000 to 103.**

The disks are constructed from light alloy and are 14 in. (356 mm) diameter, 0.050 in. (1,3 mm) thick, coated approximately 0.0001 in. (0,003 mm) thick on each side with epoxy bonded magnetic iron oxide.

The usable section (that is, amount traversed by R/W heads) of each disk is 2 in. (50,8 mm) wide from track 000 to track 202. The inner track (202) is at 4.5 in. (114,3 mm) radius and the tracks are 0.010 in. (0,25 mm) apart.

Models 1 and 2 use two disks (four recording surfaces) and Model 3 uses one disk (two recording surfaces). On Model 1 only tracks 000 to 103 are used for recording; access to the other tracks is limited by the access mechanism.

Fixed Disk

- **Where two disks are used, the lower disk is permanently mounted on the hub assembly of the drive spindle.**

Fixed Lower Disk Hub Assembly

- **The hub assembly is a push-fit on the drive spindle.**

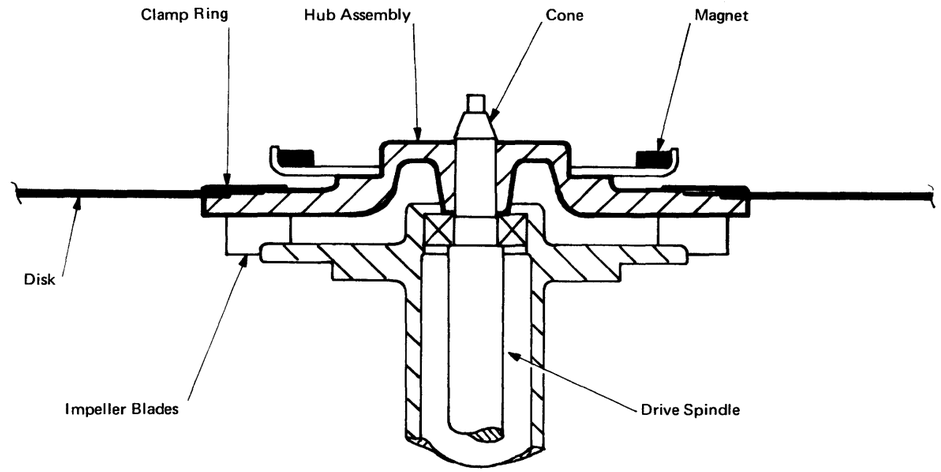


Figure 1-9. Lower Disk Hub Assembly [07469]

The fixed lower disk is secured on the hub assembly by a clamp ring (Figure 1-9). Eight impeller blades on the base of the hub assembly force air through the filter. A magnetic ring clamps the removable upper disk assembly to the fixed disk hub assembly.

Removable Disk

- **The removable upper disk on its hub assembly is permanently enclosed in the 5440 Disk Cartridge (Figure 1-10) to protect the recording surfaces.**
- **The upper disk hub assembly is magnetically clamped to the lower disk hub assembly and seats on the drive spindle cone.**
- **For storage, the removable disk in its cartridge is placed into the bottom cover.**

Upper Disk Hub Assembly

- **The removable upper disk is clamped to the upper disk hub assembly, which is magnetically clamped to the lower disk hub assembly.**

A clamp ring secures the disk to the upper disk hub assembly (Figure 1-11) and the armature ring clamps to the ring magnet of the lower disk hub assembly, locking the two disks together on the drive spindle (Figure 1-12). The upper disk hub assembly seats on the drive spindle cone (see Figure 1-12).

For storage, the removable disk is placed in the cartridge bottom cover; the armature ring clamps onto four magnets (see Figure 1-13) to seal the cartridge covers. An index slot in the armature ring is used with a transducer to provide an index pulse to indicate the start of each recording track on the upper disk.

5440 DISK CARTRIDGE

- **The disk cartridge is held in position on the machine by two cartridge clamp arms.**
- **When the cartridge is installed, the bottom cover is stored on top of the upper disk enclosure.**

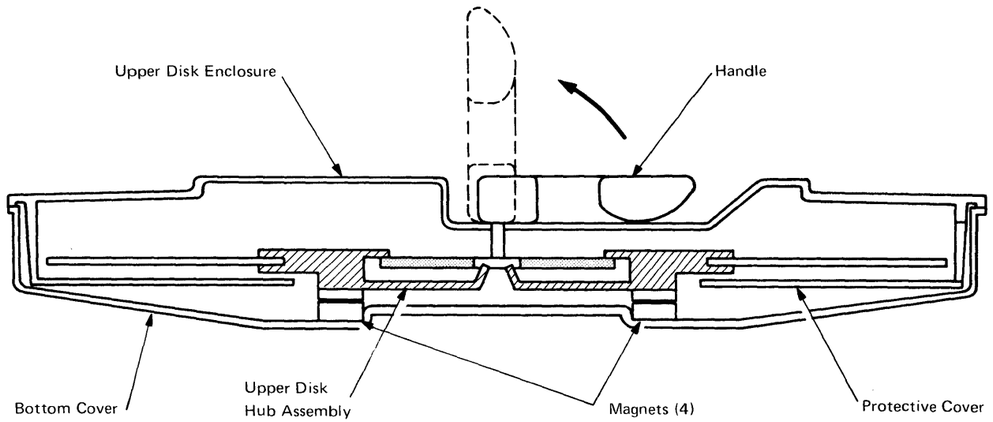


Figure 1-10. 5440 Disk Cartridge [07470]

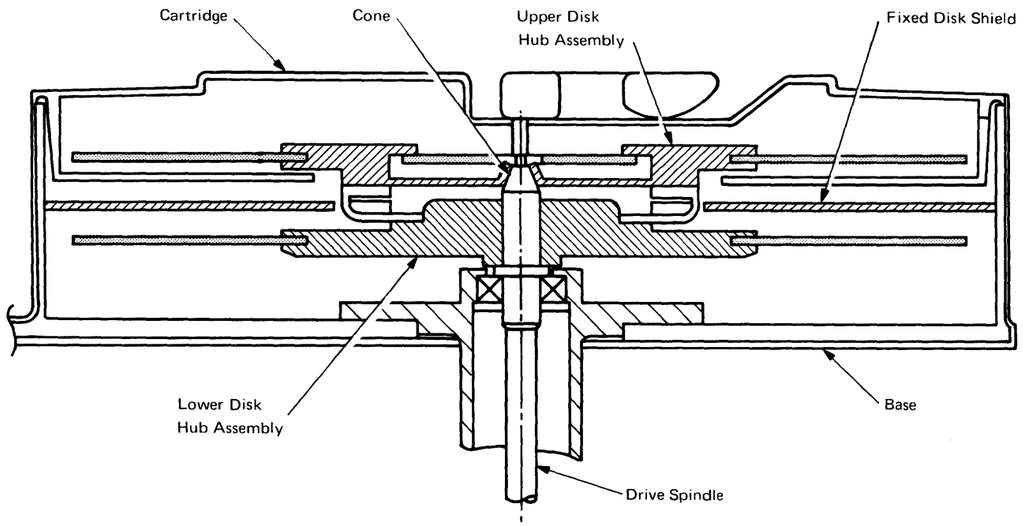


Figure 1-12. Cartridge on Drive Spindle [07472]

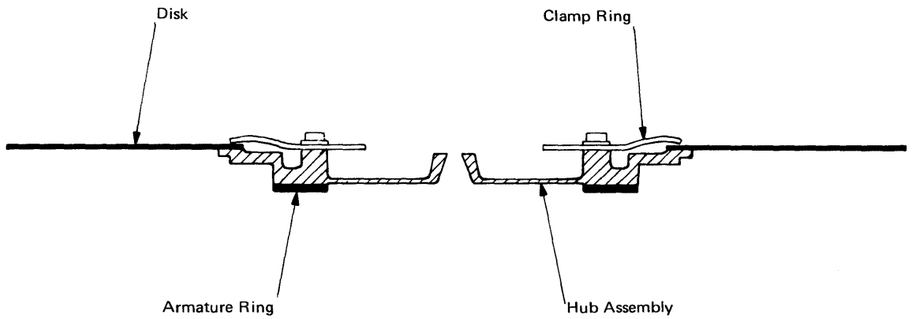


Figure 1-11. Upper Disk Hub Assembly [07471]

- **The cartridge carrying handle is used to release the cartridge from the drive spindle, and to release the cartridge bottom cover.**

The removable upper disk on its hub assembly is enclosed between the upper disk enclosure and the protective cover of the cartridge.

When the cartridge is installed in the 5444, the upper and lower disk hub assemblies are locked together on the drive spindle (see Figure 1-12). The upper disk hub assembly seats on a cone at the top of the drive spindle.

To allow the read/write heads and the cleaning brushes to enter the upper disk enclosure, a head entry port and a brush entry port are formed in the side wall of the upper disk enclosure. Four slots in the side wall of the upper disk enclosure enable accurate location of these ports.

When removed from the machine, the upper disk enclosure is placed in a bottom cover (see Figure 1-10). Four ring magnets, set into the bottom cover (see Figure 1-13), clamp the hub assembly to the bottom cover.

The cartridge is moulded from polycarbonate. Customer cartridges have a blue top cover with a dull white bottom cover; CE cartridges have a black top cover and dull white bottom cover. The disk cartridges may be used in any 5444. One version of the disk cartridge is common to all models of the 5444.

Cartridge Clamp Arms

When the cartridge is in use, the bottom cover fits on top of the disk enclosure. Both are then held in position by two cartridge clamp arms (see Figure 1-1). The clamp arms actuate two cartridge interlocks that form part of the machine interlock circuits. These interlocks inhibit machine start-up if the cartridge or bottom cover are positioned incorrectly.

The clamp arms, when swung away to permit cartridge removal, operate a drawer stop at each side of the machine. These stops prevent the machine being closed into the drawer while the clamp arms are in the 'release' position.

Cartridge Handle

The cartridge carrying handle is also used for removing the cartridge from the 5444 drive spindle, or for releasing the disk from the cartridge bottom cover when removed from the machine.

To release the disk, the handle is lifted and at the same time the cartridge release catch (Figure 1-13) must be held against its spring; rotation of the handle then forces open the magnetic seal between the upper and lower hub assemblies.

To refit the disk, it must be positioned correctly on the drive spindle or in the cartridge bottom cover, and the handle allowed to drop.

For normal carrying purposes, the handle is lifted from its horizontal rest position.

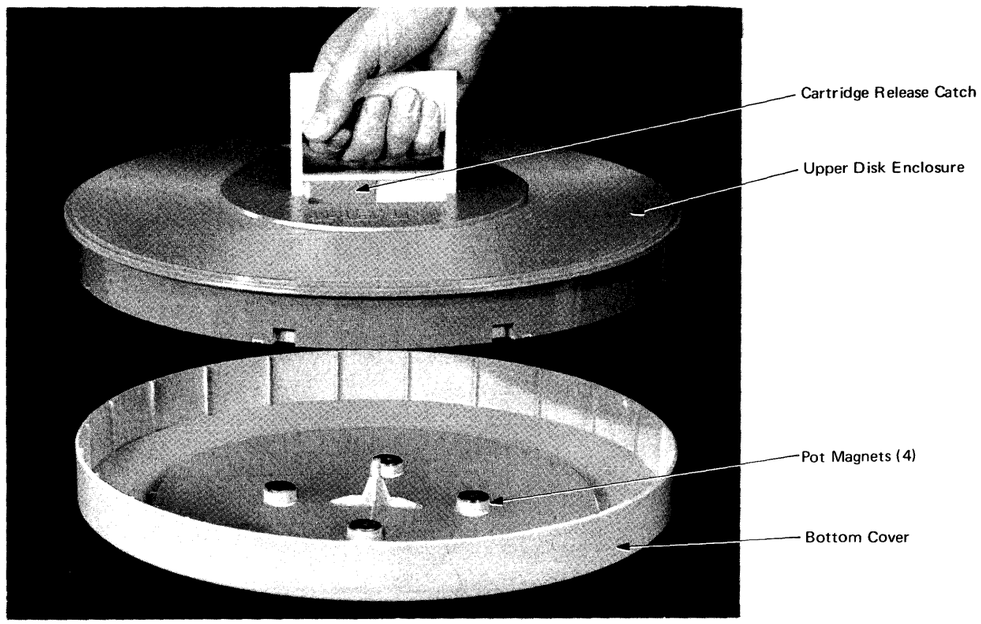


Figure 1-13. Cartridge Handle and Release Catch [07473]

Disk Cartridge Handling and Storage

When not using the handle, the cartridge should be held with the fingers in the recessed handle compartment, the thumb gripping the bevelled edge set into the bottom cover.

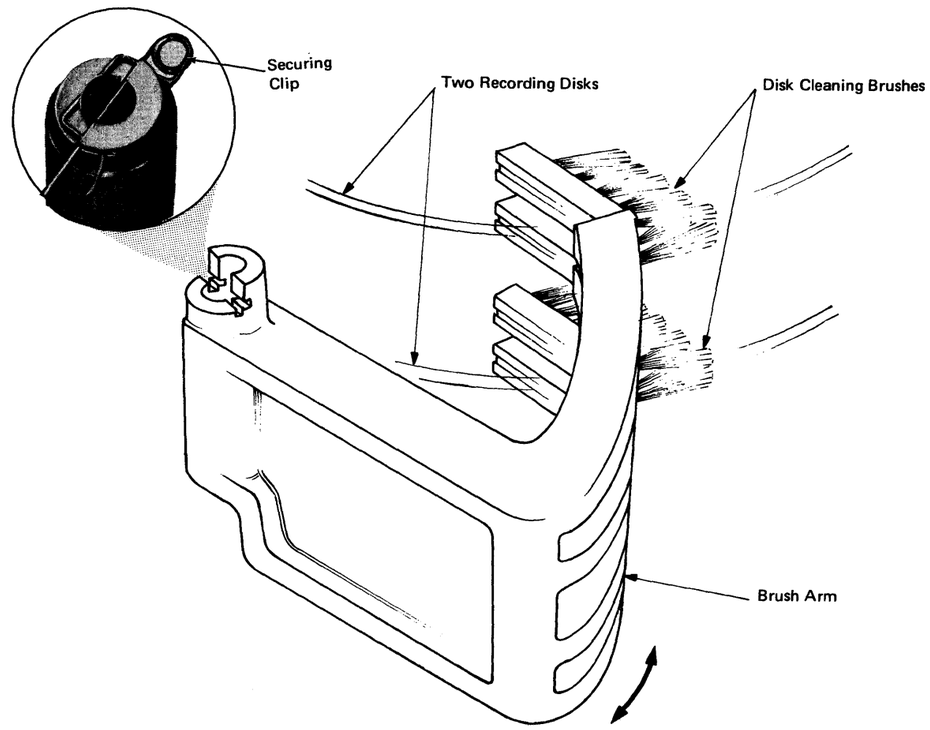
Disk cartridges should be stored on top of each other, or standing on edge in racks. To facilitate stacking, a raised portion in the top fits into a recessed area in the bottom of the next cartridge.

DISK CLEANING BRUSHES

- **Two pairs of cleaning brushes are used to sweep dust particles from the recording surfaces.**
- **This brush sweep cycle forms part of the file start up sequence.**
- **The sweep cycle takes approximately one minute.**

The read/write heads fly at 80 to 100 microinches above the disk surfaces. To avoid any head-to-disk interference, contamination must be removed from the recording surfaces. Two sets of cleaning brushes (Figure 1-14) are used during the start-up sequence to sweep the recording surfaces of the disks before the heads are loaded onto the disks. This sweep cycle takes approximately one minute. The 'ready' line is not activated until the brushes return to the parked position.

The brushes are mounted on a brush arm, which is driven across the disks by the brush motor via a link and cam mechanism (Figure 1-15). The brush motor is activated by the '+24V file start' line. When the cam rides against the forward stop, the brush motor reverses automatically, and the brushes start to return to the parked position off the disks. The cam operates the 'brush cycle complete' microswitch and stops the brush motor; the cam is now resting against the parked stop.



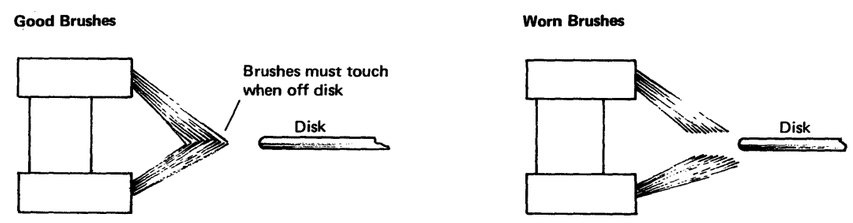


Figure 1-14. Disk Cleaning Brushes [07474]

Brush Microswitches

Two microswitches (brush mid-cycle, and brush cycle complete) are actuated during the brush sweep cycle to provide timing signals for use in the machine start-up sequence. The switches are operated by a cam fixed to the brush motor drive shaft (see Figure 1-15).

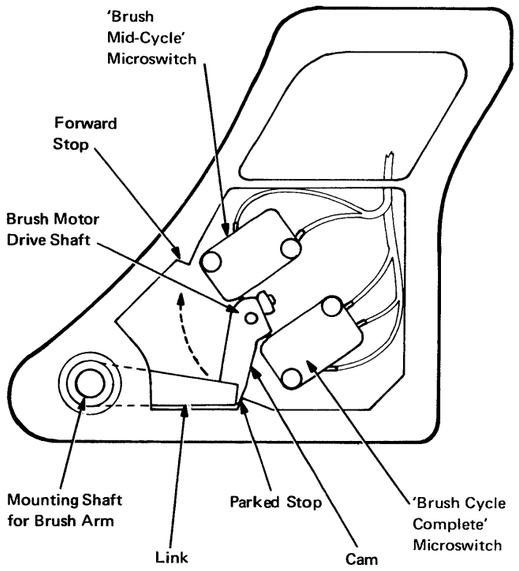


Figure 1-15. Disk Cleaning Brushes Linkage Mechanism [07475]

Brush Motor

The brush motor is a synchronous motor: the output spindle rotates at approximately 2 rpm. Because the 5444 can be operated from 50 Hz and 60 Hz power supplies, different brush motors are available (see Appendix B).

ACTUATOR

- **The actuator positions the read/write heads at track addresses defined by the using system.**
- **The carriage holds and positions the read/write heads over the disks.**
- **The access mechanism moves the carriage.**
- **The detent mechanism stops the carriage.**
- **Inner and outer limit switches restrict carriage movement.**

The actuator (Figure 1-16) accurately positions the four read/write heads at the track address defined by the using system. This positioning is carried out within a specified time, the external control signals being provided by the using system.

Carriage

- **The carriage moves on linear ball slides within the actuator frame carrying the read/write heads over the disks.**
- **The read/write heads are in a loaded condition as they move out.**

The carriage is mounted within the actuator frame and runs on linear ball slides. Read/write heads on support arms are fitted into slots in the carriage. As the carriage moves along the actuator frame, the read/write heads move across the disk surfaces. Switches attached to the actuator frame prevent the carriage from hitting its limits of travel.

Four head load spring shafts (Figure 1-17) on the carriage are operated by a geared linkage mechanism coupling all four shafts together to load simultaneously. The linkage is operated by a flexible head load cable and a head load lever attached to shaft number 02. The head load mechanism has a mechanical knock-off (trip arm and trip) to unload the heads if the carriage is retracted off the disks with the read/write heads still loaded. The head load mechanism is described later in this chapter.

Actuator Mechanism

- **Carriage movement is obtained from a rotating leadscrew.**
- **The leadscrew drives a follower wheel mounted in the carriage.**
- **Motive power for leadscrew rotation is obtained from a layshaft via a drive tire and flexible drive disk.**
- **One of the two clutches holds the flexible disk against the drive tire to give the required direction of carriage movement.**

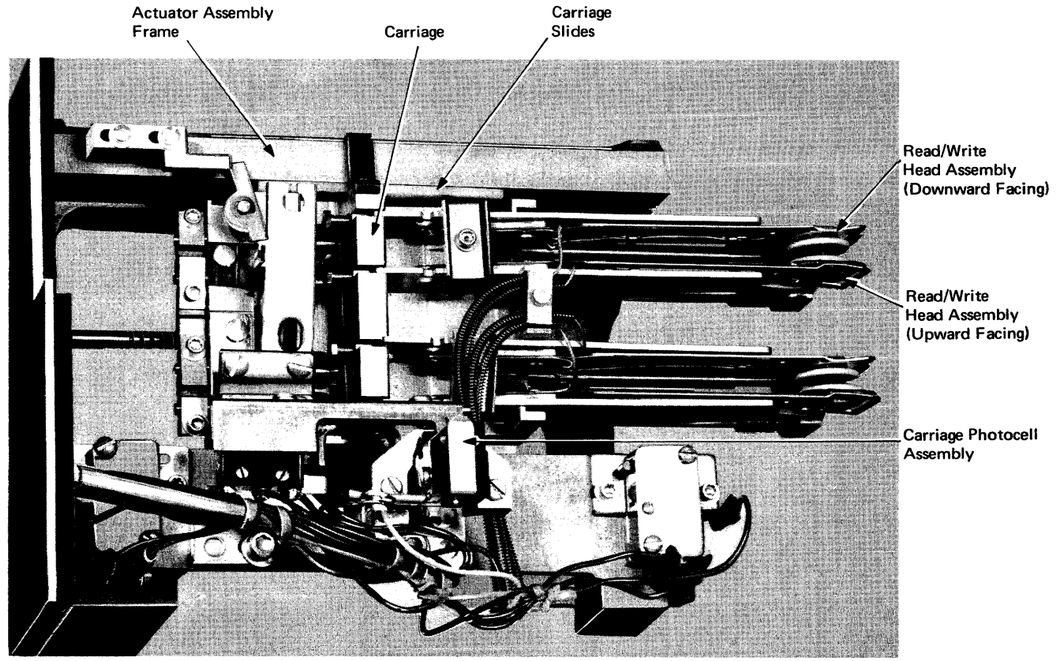


Figure 1-16. Actuator Assembly [07476]

The carriage is driven long the actuator frame by a leadscrew acting on a spring-loaded follower wheel and rollers attached to the carriage (Figure 1-18). The leadscrew is held in bearings at each end of the actuator frame and is rotated from the layshaft (see Figure 1-20). The layshaft is driven from the drive motor via a drive belt and rotates continuously while the machine is in operation. A flexible stainless steel drive disk is attached to the end of the leadscrew (Figure 1-19).

One of two clutch pads holds the drive disk against the rotating drive tire. The upper (forward) clutch holds the disk against the upper driving surface of the tire to move the carriage towards the center of the recording disks. The lower (reverse) clutch holds the disk against the lower driving surface to move the carriage away from the center of the recording disks.

A pressure pad fixed to the end of each clutch armature prevents wear on the drive disk when the disk is held against the drive tire. When a clutch is energized, the pressure pad moves towards the drive tire, forcing the flexible disk against the tire driving surface. When the clutch is de-energized, a return spring returns the armature holding the pressure pad to its stop position.

The leadscrew has a pitch of 0.1 in. (2,54 mm). One

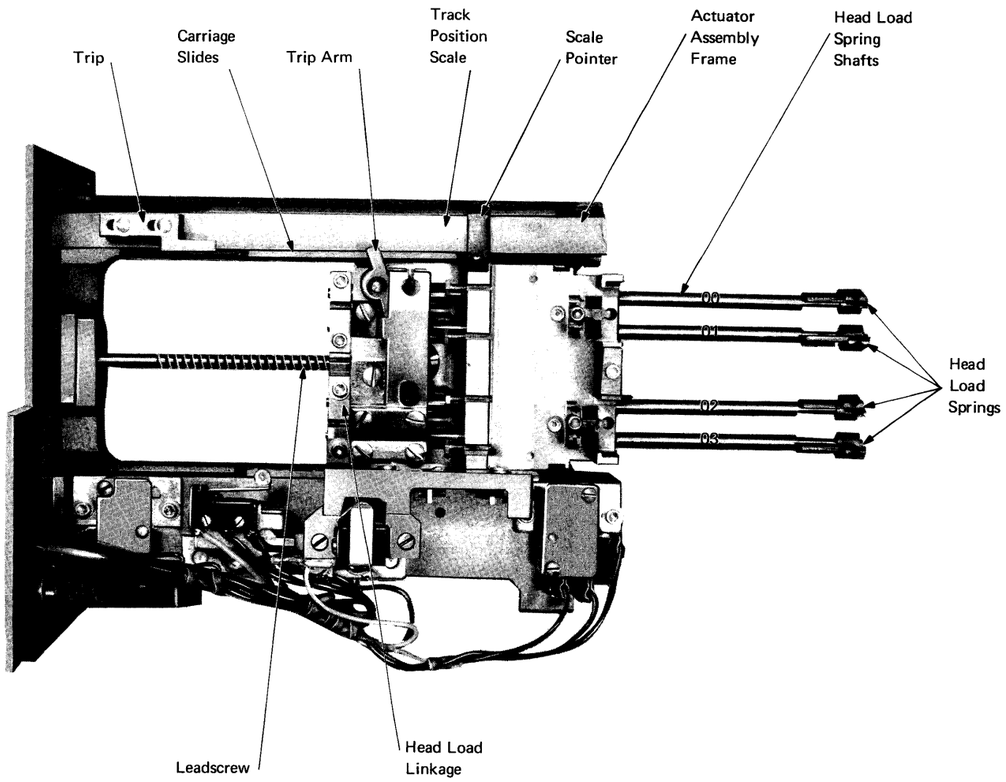


Figure 1-17. Carriage and Actuator Assembly – Without Heads [07477]

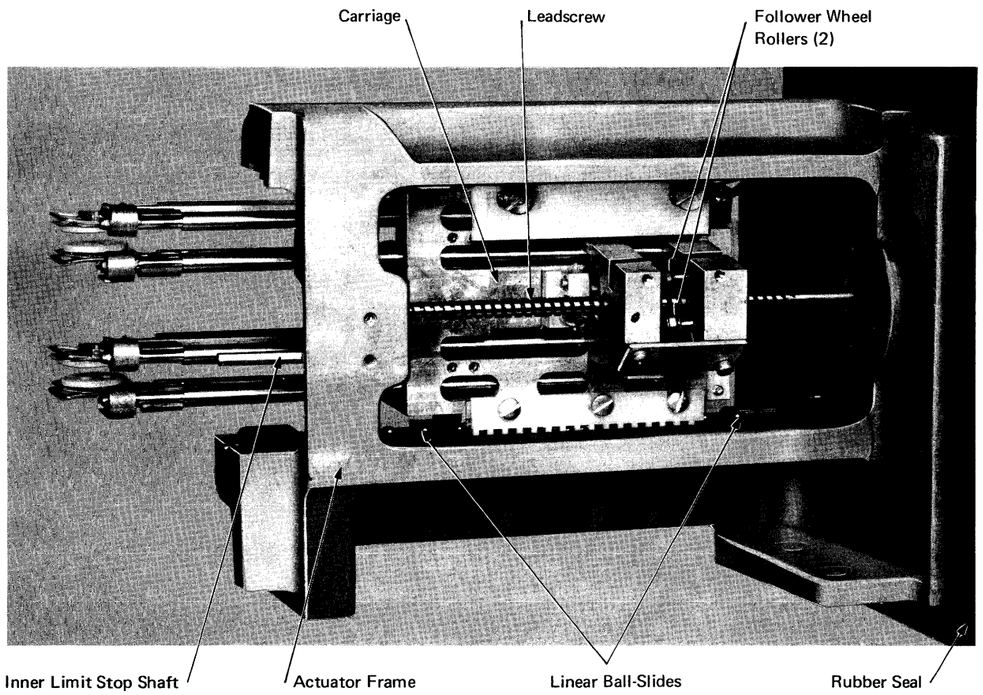


Figure 1-18. Leadscrew and Follower [07478]

revolution of the leadscrew, therefore, causes the carriage to move 0.1 in. that is, 10 tracks at the disk track density of 100 tracks per inch.

Detent Mechanism

- **Two detent pawls engage in a detent wheel to stop carriage movement.**
- **During an access operation, a yoke holds the pawls clear of the detent wheel.**
- **The yoke is driven by a voice coil.**

The general view of the detent mechanism is given in Figure 1-20. Two spring-loaded pawls engage in a detent wheel, which acts on the leadscrew and stops the carriage to position the read/write heads accurately. Each detent pawl (Figure 1-21) pivots on a leaf spring and is held into the detent wheel by a pawl spring.

To allow the leadscrew to rotate, the voice coil is energized, pulling back the yoke which holds the pawls clear of the detent wheel. To stop the leadscrew the voice coil is energized in the other direction to drive the yoke towards the detent wheel. The pawl springs cause the two pawls to engage in the teeth of the detent wheel.

One revolution of the detent wheel corresponds to a carriage movement of 10 tracks. The detent wheel has 10 teeth; therefore, one tooth movement corresponds to one track movement of the carriage.

Voice Coil

The voice coil is fixed to the yoke and is center-tapped; when one half is energized it moves the yoke forwards, and when the other half is energized moves the yoke backwards. The yoke engages and disengages the pawls in the detent wheel.

When the using system signals the carriage to move, the yoke pulls the detent pawls clear of the detent wheel. One of the two clutches energizes to drive the carriage; when the carriage nears the specified track, the clutch de-energizes. The yoke moves in the reverse direction and allows the pawls to engage in the detent wheel, stopping the carriage at the correct track.

A 1.8 ms pick pulse (pick 1) and a hold current are

applied to the disengage half of the coil. After the pick pulse drops, the coil continues to move because of the hold current. When the coil reaches its limit of travel against a resilient stop, a 0.8 ms pick pulse (pick 2) is applied to the coil, and holds the coil against the stop to suppress bounce.

Pick 2 is derived from the back electromotive force (emf) generated in the undriven (engage) half of the coil.

The action to engage the pawls is similar but the functions of the voice coil halves are reversed. The disengage half of the coil provides a back emf sense signal for the engage half. The level of hold current for the engage action is 235 mA and for the disengage action 590 mA.

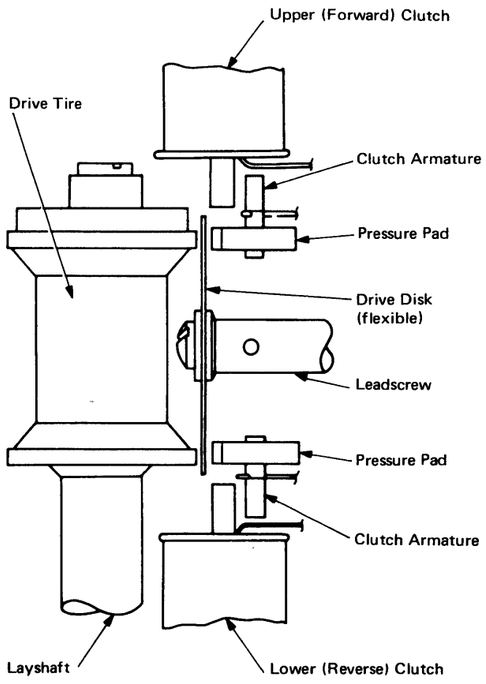


Figure 1-19. Layshaft/Leadscrew Drive [07479]

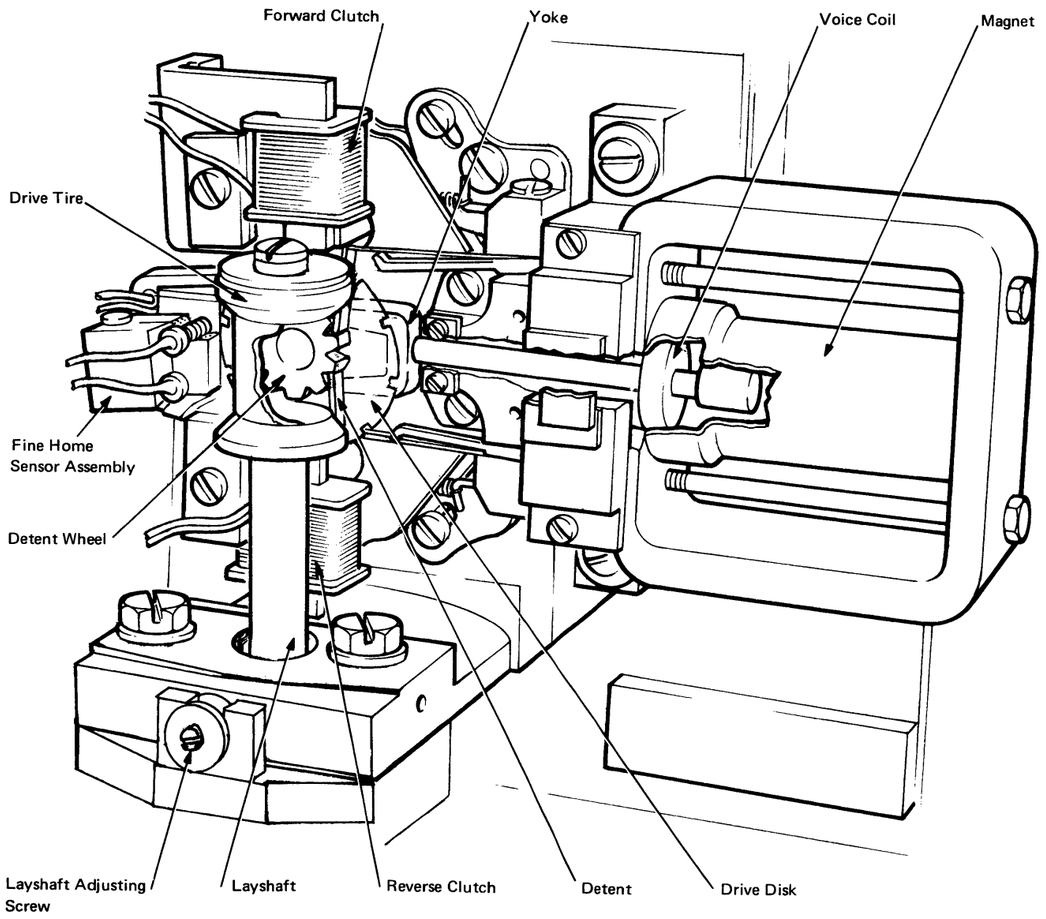


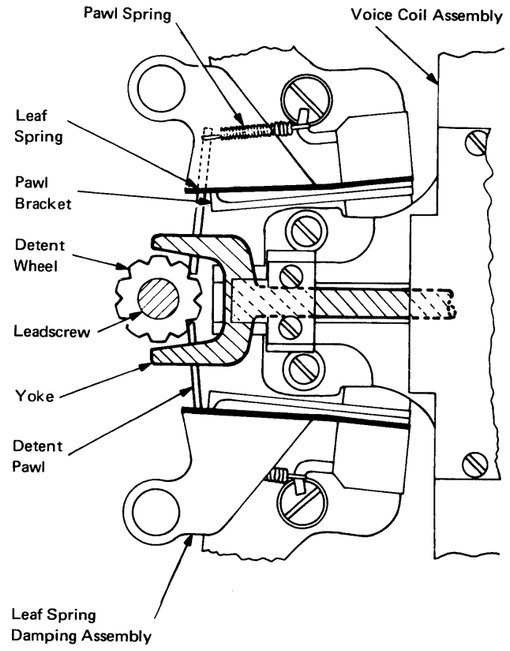
Figure 1-20. Detent Mechanism [07480]

HEAD/ARM ASSEMBLY

- The head/arm assembly consists of a read/write head, support arm, and connecting cable and plug.
- The four head/arm assemblies are clasped to the carriage.
- The carriage moves within the actuator frame carrying the heads over the disks.

Read/Write Head

- The read/write head is mounted on a ceramic slider and contains a read/write coil, and an erase coil.



Note: Drive tire, drive disk, and clutches omitted for clarity

Figure 1-21. Detail of Detent Mechanism [07481]

- **The erase coil follows the read/write coil to trim the edges of the written data tracks.**

The read/write head (Figure 1-22) contains a read/write coil wound on a single core and an erase coil wound on a yoke. The read/write pole gap is followed by the split erase pole tips to 'side' erase the edges of the written data tracks; the erase pole tip is made in the form of a yoke. The erase coil is connected to the center tap of the read/write coils and is always energized when writing.

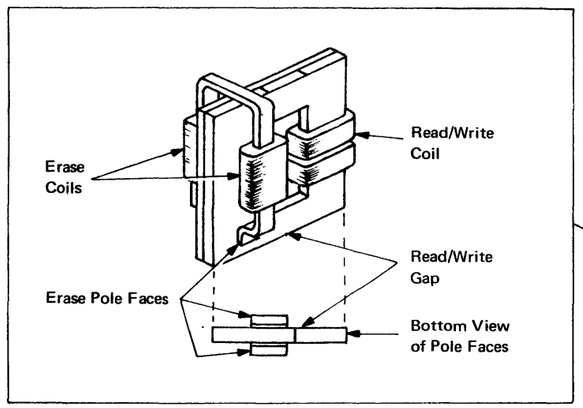
Head Support Arm

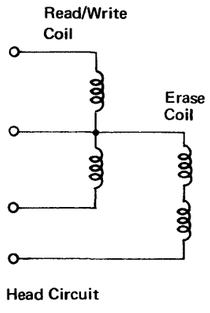
- **The head support arm holds and positions the read/write head.**

- **The head load spring provides the loading force to hold the read/write head above the disk surface.**

The read/write head on its ceramic slider is mounted on a leaf spring screwed to the support arm (Figure 1-23). The support arm fits into a slot in the carriage and the head/arm assembly is adjusted in this slot to position the head exactly (tracking adjustment) over the center of a particular track.

When the heads move over the disk surface, the head load spring is moved by turning the head load shaft to hold the ceramic slider down against the pressure of the air film and therefore maintain the correct slider-to-disk spacing. A flexure spring allows the head to move freely about axes tangential to, and radial to, the recording track. The leaf spring allows the head to move up and down to keep the correct angle relative to the disk surface.





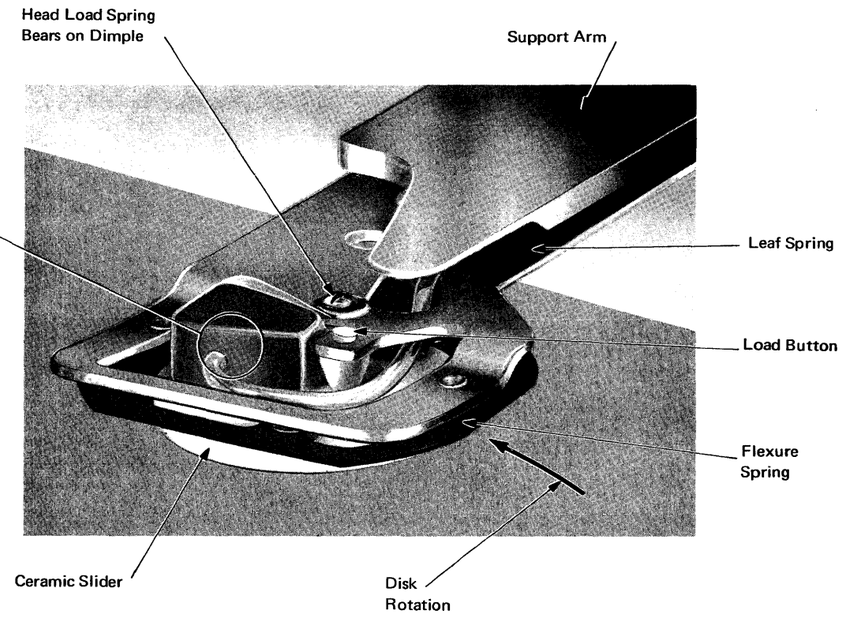


Figure 1-22. Read/Write Head [07482]

Flying the Heads

- **The ceramic slider floats just above the rotating disk surface on a thin film of air.**

- **The head-loading mechanism is designed to fly the head at a specified height above the disk surface.**

The film of air beneath the ceramic slider acts as a lubricant between the slider and the rotating disk surface. While this air film is maintained, no wear or abrasion can occur. The spinning disk forces air between the disk and the slider, lifting the shoe against the head load; at this point, the head is "flying". Two bleed holes in the slider partially relieve the pressure build-up beneath the shoe.

The head load spring bears upon a dimple on the leaf spring (see Figure 1-22), which transfers the head loading via the load button to the ceramic slider. The leaf spring is biased against the support arm by approximately 40 grams. To overcome this bias the head load spring provides a load of 286 grams. This places a load of 246 grams on the slider to just balance the upward force from the air film, allowing the slider to fly. The flying height is 80 microinches at the inner track, and 99 microinches at the outer track.

Read/Write Signal Level

- **The read/write signal level is greater at the outer track than at the inner track.**

For a given load, the head flies at a height proportional to the velocity of the disk. Because the velocity of the disk surface is greater at the outer track than at the inner track, the flying height at the outer track is greater than the flying height at the inner track.

The read signal increases as the head approaches the outer track (the induced voltage at the head is proportional to the rate of change of flux lines with time, and hence to disk velocity), but this effect is somewhat reduced because the head is further away from the disk surface.

Write current is increased for tracks 000 through 120 (approximately) to compensate for the increased flying height at the outer tracks.

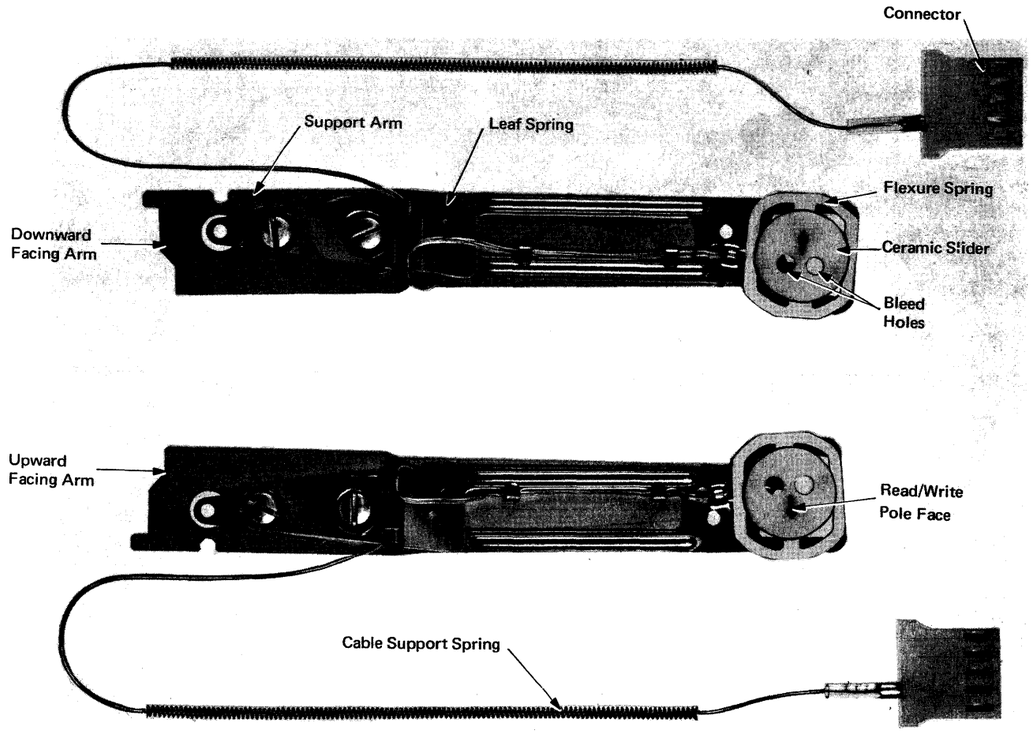


Figure 1-23. Head Assembly [07483]

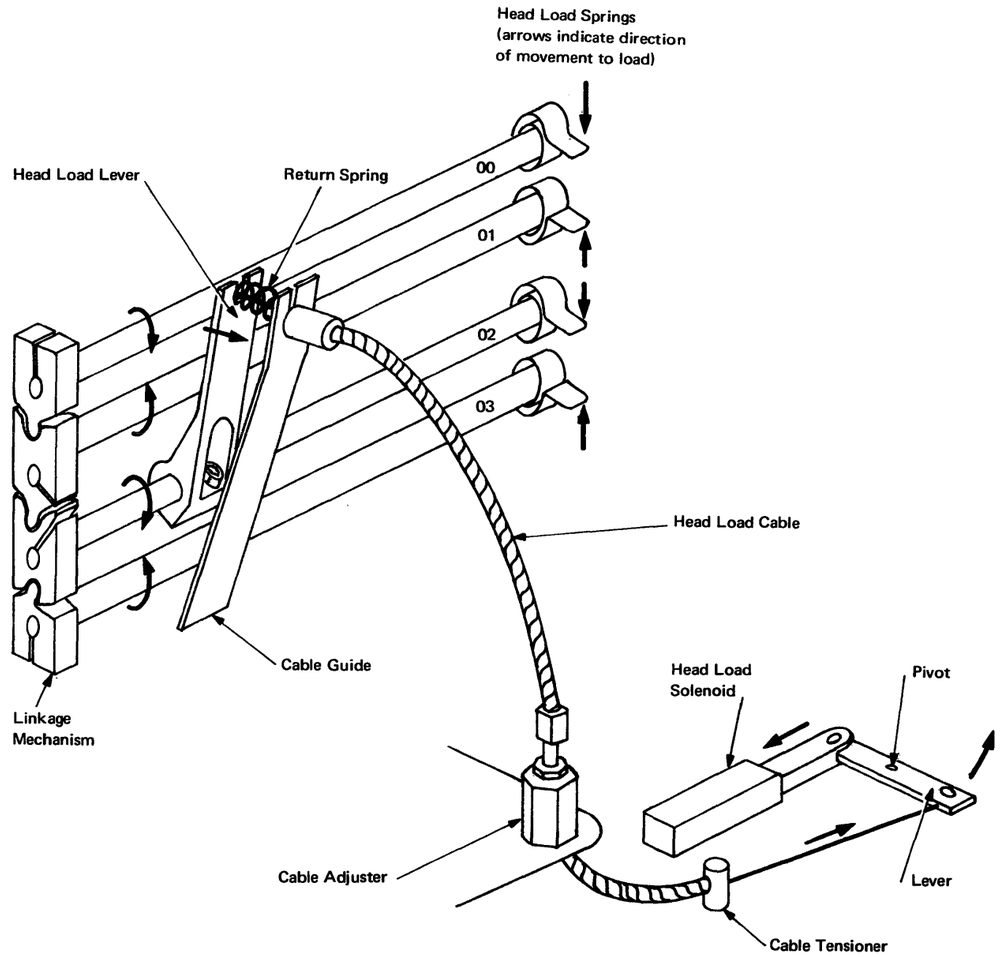


Figure 1-24. Head Load Linkage [07484]

HEAD LOAD MECHANISM

- **Each read/write head is loaded by a head load spring on the head load spring shaft.**
- **The four head load shafts are turned by a solenoid acting through a cable and linkage.**
- **The heads unload automatically if the disk speed falls below 64% of maximum, or if a data unsafe condition exists.**
- **A knock-off mechanism is incorporated to ensure that the heads are unloaded before leaving the disk.**

When the 5444 is not in use, the head/arm assemblies are unloaded and retracted off the disks. The heads are not loaded until the disk reaches full speed, the brush cleaning cycle is completed, and the heads are detented at track 000.

To load the heads, the head load solenoid (Figure 1-24) pulls on the head load cable to operate a linkage on the head load spring shafts (Figure 1-25). The shafts turn and the head load springs push the head sliders towards the disk surface.

When the head load solenoid de-energizes, the head load cable spring returns the head load shafts lifting the head load springs, allowing the heads to move away from the disk surface.

Head Load Solenoid Assembly

- **Contains a pick winding and a hold winding.**
- **The hold winding is shorted until the solenoid is picked.**
- **Head load interlocks 1 and 2 are operated when the solenoid is energized.**

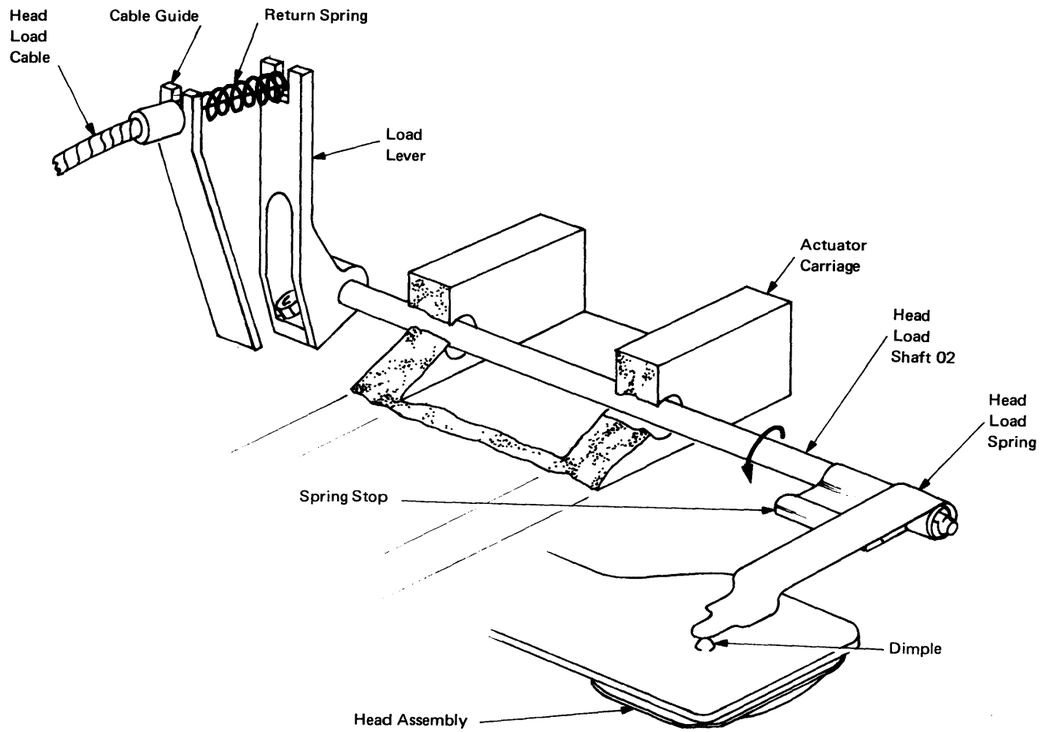


Figure 1-25. Head Load Shaft Operation [07485]

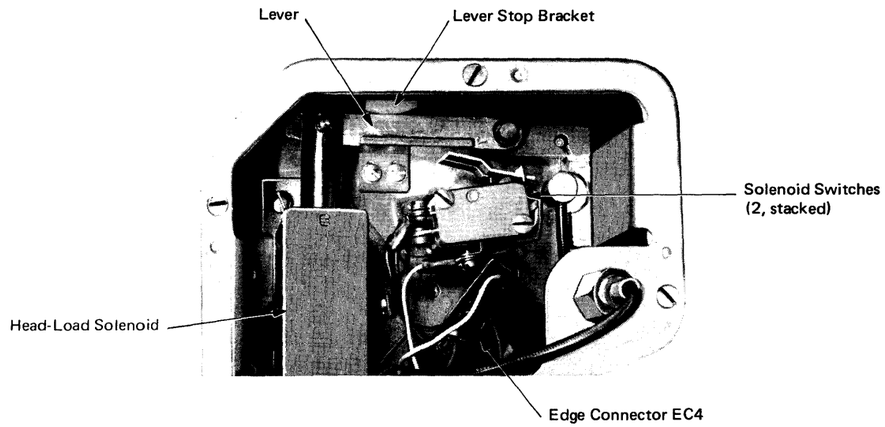


Figure 1-26. Head Load Solenoid Assembly [07486]

The head load solenoid assembly (Figure 1-26) is mounted in the base beneath a cover plate and contains: two windings connected in series, a pick winding, and a hold winding. The hold winding is shorted by head load interlock switch 1 (Figure 1-27) until the solenoid energizes. When the solenoid plunger nearly bottoms, the short circuit across the hold winding is removed, which reduces the high pick current to a low level, sufficient to hold the plunger sealed.

The plunger movement is transferred to the operating cable by a lever arm, which operates head load interlock switches 1 and 2. Interlock switch 2 raises the 'head loaded OK' line.

Knock-Off Mechanism

- **If tripped, the mechanism must be reset by a CE.**
- **Must be reset before the heads can be loaded.**

Under certain fault conditions, the heads could still remain loaded when retracted past track 000 towards the edge of the disks. As a protection, an off-disk interlock switch operates between tracks 003 and 005 to unload the heads before they reach the edge of the disk. A further protection is a mechanical knock-off in the head load mechanism.

The mechanical knock-off (Figure 1-28) consists of a support spring for the head load cable guide, a trip on the actuator frame, and a knock-off trip arm on the head load lever. A leaf spring at the base of the cable guide biases the guide towards the carriage. During normal operation, the support spring holds the cable guide away from the carriage, against the tension of the leaf spring. If the trip arm pushes the support spring away from the cable guide, the guide is allowed to spring in towards the carriage to unload the heads.

If the mechanism is tripped, the fault must be retified before the heads are reloaded. *Resetting the mechanism must only be performed by a CE.*

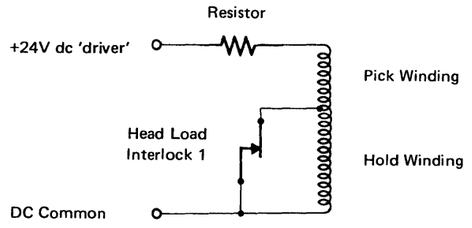


Figure 1-27. Head Load Solenoid Circuit [07487]

AC BOX

The ac box is mounted at the rear of the 5444 (see Figure 1–4) and contains the following:

1. Terminal block for the ac input supply from the using system.
2. Two line filters.
3. Three relays: K1 (drive motor relay), K3 (brush motor relay), and K5 (drive motor brake relay).
4. Drive motor capacitor.

The ac box is connected to ac ground and is electrically isolated from the base (the base casting is connected to logic ground). The ac supply is distributed from the ac box to the drive motor and the brush motor; all connections are via a terminal block.

DC BOX

The dc box is mounted beneath the ac box (see Figure 1-4) and contains the following:

1. Terminal block for the dc input supply from the using system.
2. Two relays: K2 (dc control relay) and K4 (head load relay).

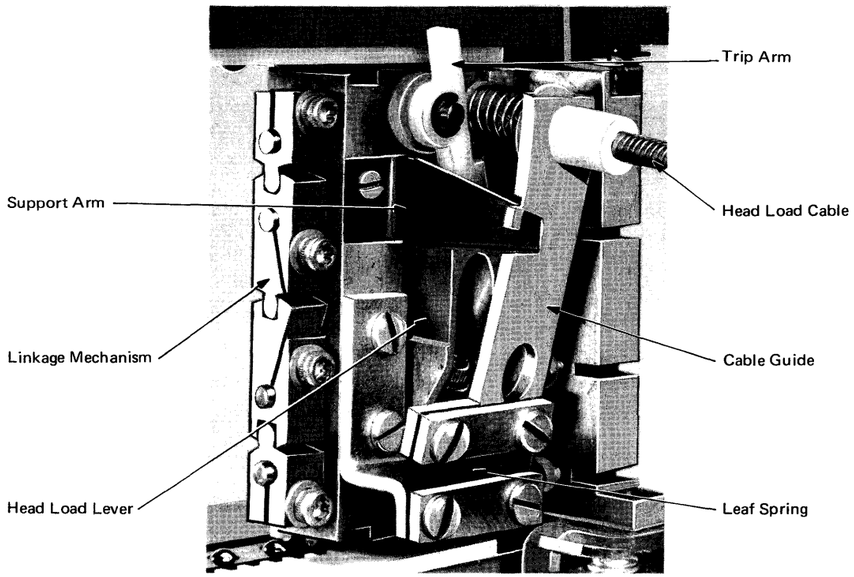


Figure 1-28. Knock-Off Mechanism [07488]

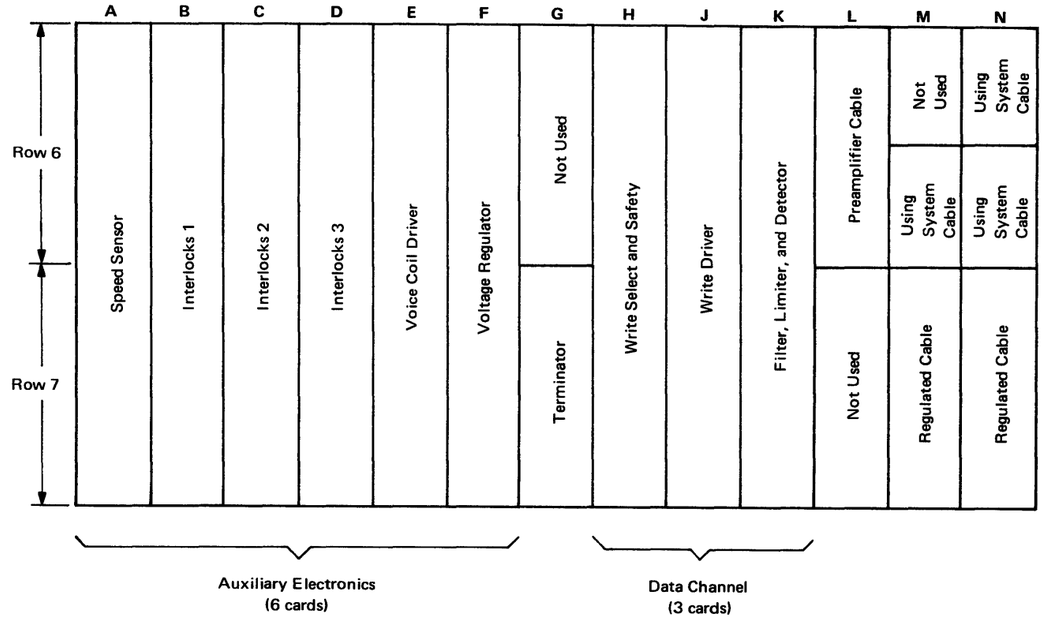


Figure 1-29. Logic Gate Card Layout [07489]

3. Two CE switches, mounted externally.
4. One SLT card (1 wide by 2 high) containing external components for the interlock circuitry.

The dc box is connected electrically to the base. Two CE switches ('mode-select' and 'forward/reverse') are mounted on the CE control panel on top of the dc box; detailed descriptions of these switches are given in Chapter 6. The box hinges open for ease of servicing.

RESISTOR BOX

The resistor box is mounted above the drive motor at the rear of the 5444 (see Figure 1-4) and contains the high-heat dissipation resistors of the voice coil detent control circuit.

AUXILIARY ELECTRONICS

- **Forms the interface between the using system and the 5444.**
- **Includes all electronics on the machine other than data channel electronics.**

The auxiliary electronics, which employ SLD-100 logic, are contained on six solid logic technology (SLT) cards within a 2 x 13 SLT board (Figure 1-29). Figure 1-30 is a schematic diagram of the auxiliary electronics. The '+24V dc driver' common line is grounded at the using system.

Electronic Interlocks

The electronic interlocks which interface between the 5444 and the control signals from the using system, control the solenoids, relays, and motors on the 5444, and process signals from microswitches and transducers. The interlocks:

1. Condition the start/stop sequencing.
2. Use command signals from the using system.
3. Protect against damage by operator error.
4. Limit damage caused by machine failure.
5. Provide machine status information to the using system.
6. Provide CE test facilities.

Switch Interlocks

- **The switch interlock circuits are shown in Figure 1-31.**

Five interlock switches have associated level converters that produce the required logic levels:

1. Off-disk interlock.
2. Brush cycle complete interlock.
3. Carriage overrun interlock.
4. Carriage retracted interlock.
5. '+24V file start' line.

The brush mid-cycle interlock and the head load interlock 2 require only a resistor to interface with the logic.

Cartridge Interlocks: Two interlock switches connected in series with '+24V file start' to prevent machine start-up when the cartridge and cartridge bottom cover are not in position on top of the machine. The interlock switches are operated by the two cartridge clamp arms.

Brush Mid-Cycle Interlock: Provides a logic switching level 'brush mid-cycle interlock' for use in the machine start-up sequence. The interlock switch is operated by a cam attached to the brush motor spindle.

Brush Cycle Complete Interlock: Indicates completion of brush cleaning cycle and raises 'brush cycle complete' for use in the machine start-up sequence. The interlock switch is operated by a cam attached to the brush motor spindle.

Off-Disk Interlock: Mounted on the actuator frame this interlock provides, after level conversion, a logic line indicating if the read/write heads are 'off disk' or 'on disk'. The interlock switch is connected in series with

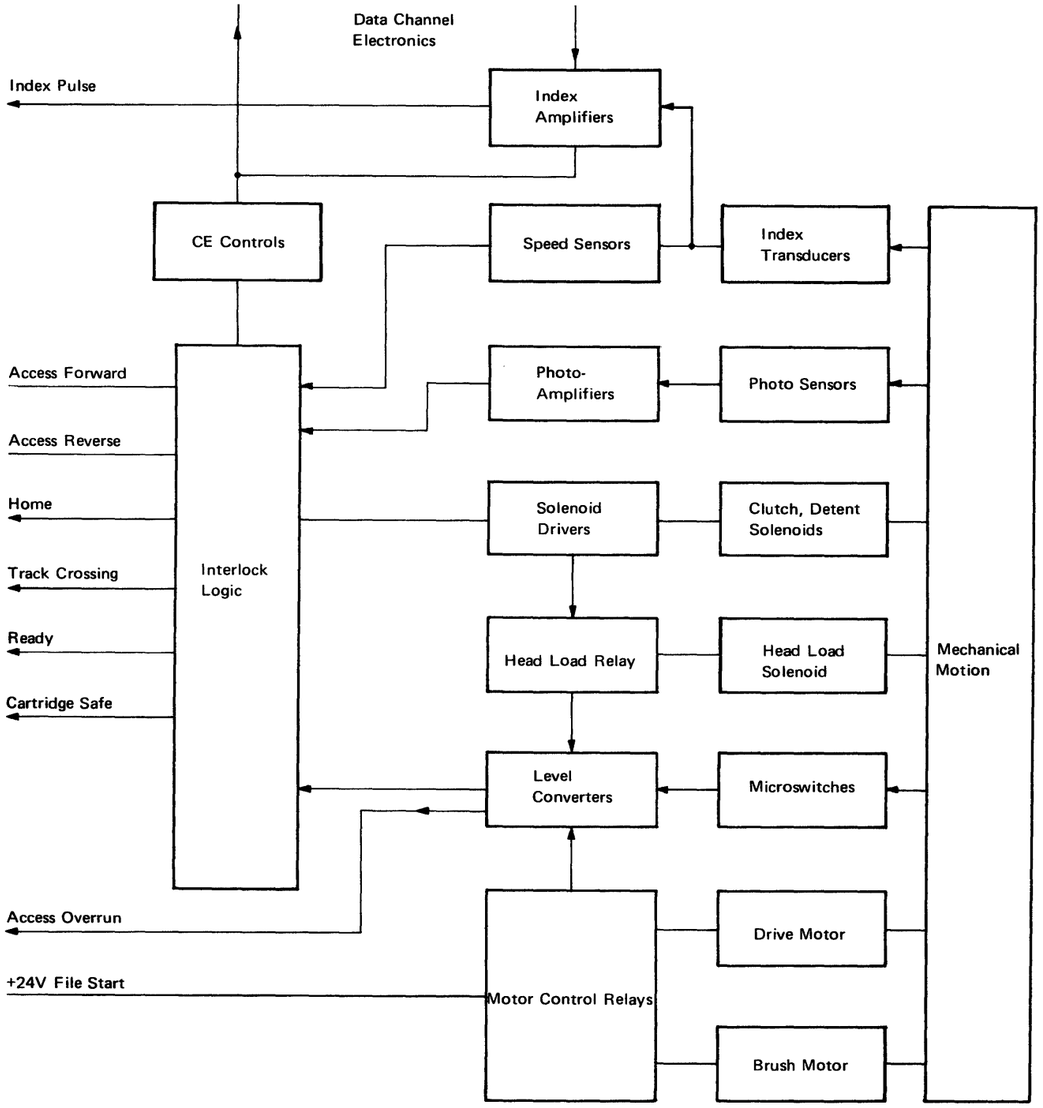


Figure 1-30. Auxiliary Electronics [07490]

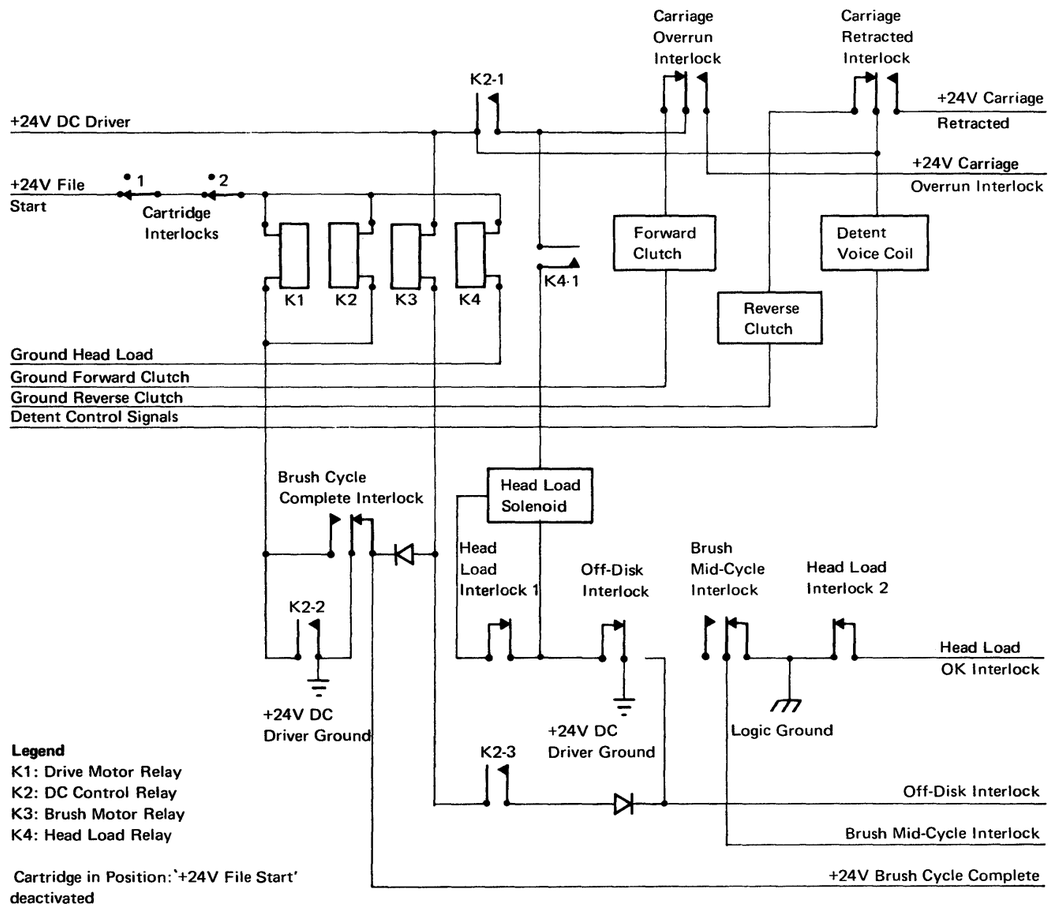


Figure 1-31. Interlock Switch Circuits [07491]

the head load solenoid and is set at track -004. The interlock unloads the heads if the carriage is retracted beyond track -004 with the heads still loaded (a fault condition).

Note: Under normal operating conditions, the carriage cannot be retracted past track 000. During a file stop sequence, the heads are unloaded as soon as the '+24V file start' line is de-activated, and before the carriage retracts past track 000. The switch remains operated while the heads are beyond track -004, preventing the heads from being re-loaded.

Head Load Interlocks: There are two head load interlock switches, both operated by the lever arm attached to the head load solenoid plunger. Head load interlock 1 removes the short circuit across the hold winding of the head load solenoid to reduce the head load current. Head load interlock 2 indicates that the heads are loaded and, after level conversion, provides the logic line 'heads loaded OK'.

Carriage Overrun Interlock: Mounted on the actuator frame, and connected in series with the forward clutch, this interlock switch prevents carriage travel past the inner limit and, after level conversion, raises the logic line 'access overrun'.

Carriage Retracted Interlock: Mounted on the actuator frame and connected in series with the reverse clutch, this interlock switch stops the carriage at the retracted position and, after level conversion, raises the logic line 'carriage retracted'.

Circuit Descriptions

Index Amplifiers (Part of Interlock 3 Card)

There are two index amplifier circuits, one for each of the two index transducers. Index amplifier 1 is used with the upper index transducer; index amplifier 2 is used with the lower index transducer. The appropriate amplifier is selected by the condition of 'disk select upper'.

The index amplifiers detect the output signals from the upper or lower index transducers and convert the signals to SLD-100 logic levels.

To indicate the start of each recording track on the disk, an index marker pulse is obtained on the 'index pulse' line for each revolution of the disk selected.

Speed Sensors (Speed Sensor Card)

The speed sensor card contains two circuits that monitor the disk speed: *speed zero detector* and *80% speed detector.*

The speed zero detector amplifier uses the output from the lower index transducer to control the 'speed zero' line. When the disk speed falls to a safe level, the 'speed zero' line raises the 'cartridge safe' line.

The 80% speed detector circuit uses the output from the upper index transducer, via index amplifier 1, to control the 'speed OK' line. During a start up sequence, the circuit detects when the disk speed is 80% of maximum (1200 rpm) and raises 'speed OK' line. The line is dropped if the disk speed falls below 64% of maximum (960 rpm).

Photo-Amplifiers (Part of Interlock 2 Card)

Three identical photo-amplifier circuits convert the output from three photocells to logic levels:

1. Track crossing photocell – provides 'track crossing' line.
2. Fine home photocell – provides 'fine home' line.
3. Carriage photocell – provides 'carriage photo cell lit' line.

Solenoid Drivers

There are five solenoid driver circuits:

1. Head load relay driver (voltage regulator card).
2. Voice coil driver (voice coil driver card, and part of voltage regulator card).
3. Forward clutch driver (interlock 3 card).
4. Reverse clutch driver (interlock 3 card).
5. Drive motor brake relay driver (interlock 3 card).

The forward and reverse clutch drive circuits are mutually exclusive: if the 'access forward' and 'access reverse' lines are active simultaneously (in error), the first line to become active takes precedence. A 1.5 ms clutch-off delay is used during the automatic control of a single track motion to ensure that the clutches stay energized long enough to move the carriage through one track.

Index Transducers

- **There are two index transducers, one for each disk.**
- **The index transducers provide a pulse indicating the start of each recording track.**

The index transducers sense a fixed location on the disks to indicate the start of each recording track. Because the upper disk is removable and is not keyed to the drive spindle, the index locations for the two disks are not identical.

The upper index transducer senses a slot cut into the armature ring on the upper disk hub assembly (Figure 1-32). The lower index transducer is fixed to the drive spindle housing to sense a metal nib attached to the drive spindle pulley (Figure 1-33). For both transducers, changes in reluctance are detected as the slot or nib passes. One pulse is detected per revolution of the disks.

The transducer output pulses are fed into two index amplifiers, one of which is selected by the 'disk select' line to correspond with the disk in use. The index marker pulse obtained indicates the start of each recording track on the disk; this marker pulse is passed to the using system via the 'index pulse' line.

The output from the lower index transducer is also fed to the speed sensor circuits to monitor the disk speed.

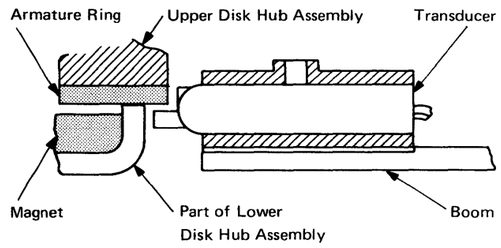


Figure 1-32. Upper Index Transducer [07492]

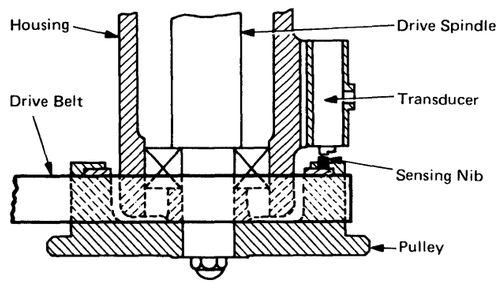


Figure 1-33. Lower Index Transducer [07493]

Track Crossing Sensor

- **Provides a pulse output for every track crossed by the read/write heads.**

Track crossing indication is provided by a lamp and photocell that senses rotation of the flexible drive disk attached to the leadscrew (Figure 1-34). The drive disk has ten slots (Figure 1-35) that allow light to pass to the photocell to produce ten output pulses per leadscrew revolution, that is, one pulse for each track crossed by the read/write heads. The output pulses are fed to a photo-amplifier to provide the 'track crossing' line. A hole in the sensor mask plate mounted immediately in front of the photocell ensures that the photocell is illuminated only from the track crossing lamp. The track crossing slots have numbers etched on the drive disk to allow the CE to visually check the track position.

Fine Home Sensor

The fine home sensor consists of a lamp and photocell monitoring rotation of the flexible drive disk (see Figure 1-34). The fine home photocell is mounted on the same printed circuit board as the track crossing photocell.

The fine home photocell is illuminated twice per revolution of the drive disk: once through the fine home hole in the drive disk and once through the warning slot (see Figure 1-35). Fine home pulses are therefore obtained at tracks 000, 010, 020, and so on. Warning pulses occur prior to the fine home pulses at tracks 001.5, 011.5, 021.5, and so on. The pulses are fed to a photo-amplifier to provide the 'fine home area' line.

Carriage Photocell

- **Provides the lines 'coarse home', and 'add write current'.**
- **With the other photo sensors, provides 'all cells lit'.**

The carriage photocell (see Figure 1-17) and lamp are mounted on the actuator frame (Figure 1-36). Illumination to the photocell is interrupted by two metal flags attached to the carriage: the *coarse home* flag, and the *add write current* flag. The coarse home flag darkens the photocell (from approximately tracks -020 to +005) to give the 'coarse home' line. The add write current flag darkens the photocell (between approximately track 115 and the carriage overrun position beyond track 202) to drop the 'add write current' line, which then drops the additional write current needed to compensate for the increased flying height of the read/write heads at the outer tracks.

Carriage Photocell Signals

The photocell is illuminated between the coarse home flag and the add write current flag, that is, between approximately tracks 005 and 115. The photocell

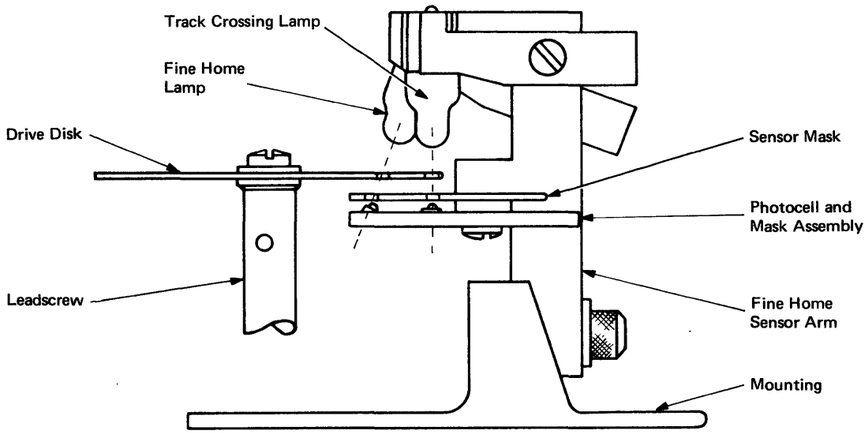


Figure 1-34. Track Crossing Sensor/Fine Home Sensor [07494]

output is fed to a photo-amplifier to provide the 'carriage pc lit' line which is used to produce three other lines: 'coarse home', 'add write current', and 'all cells lit' (Figure 1-37).

'All cells lit' is used in the machine start-up sequence to retract the heads from track 010 to track 000, prior to head loading.

'Add write current' is held on by the 'add write current' latch, which is set by 'carriage pc lit' during the machine start-up sequence. 'Carriage pc lit' drops when the coarse home flag passes the photocell (between tracks -020 and +005) and raises the 'coarse home' line.

When the heads leave track 000, the coarse home flag moves away from the photocell, activating 'carriage pc lit' at track 005 to drop 'coarse home' and raise 'add write current'. At approximately track 115, the add write current flag passes the photocell and drops 'carriage pc lit'. The 'add write current' latch resets at track 120 when the next 'fine home area' pulse occurs. The 'add write current' latch is not set again until the heads are retracted below track 115, reactivating 'carriage pc lit'.

Track 000 (Home) Indication

- **Track 000 is indicated by the logical combination of the 'track crossing', 'fine home area', and 'coarse home' signals.**

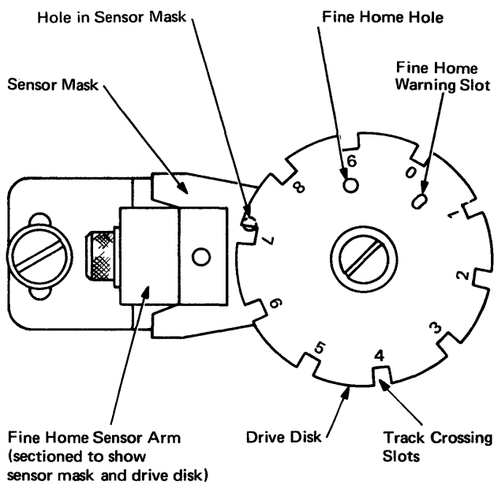


Figure 1-35. Drive Disk and Sensor Mask [07495]

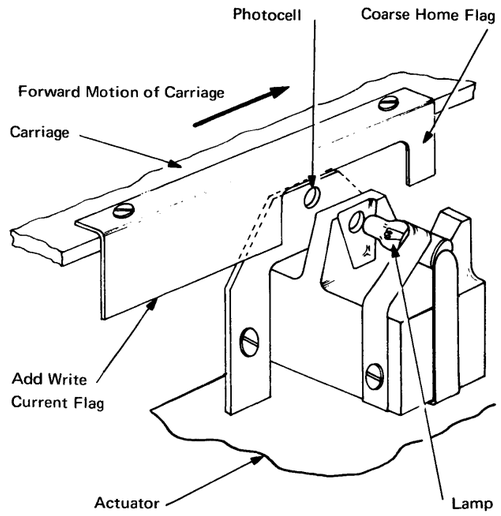


Figure 1-36. Carriage Photocell [07496]

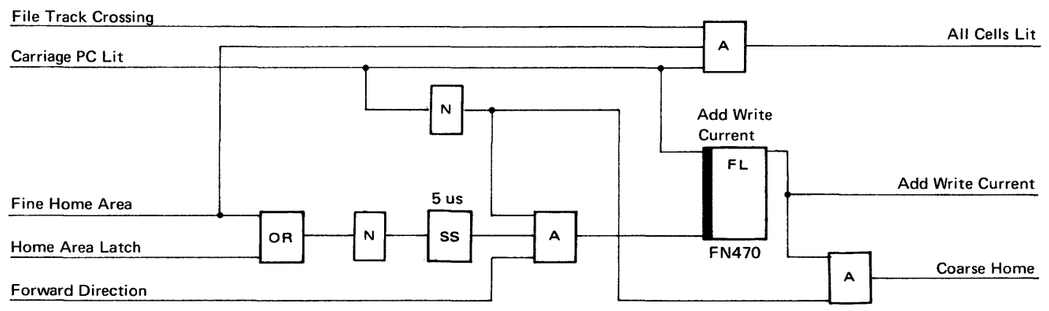


Figure 1-37. Carriage Photocell Signals [07497]

The track 000 (or home) position is a unique position (Figure 1-38) on the 5444 defined by signals obtained from the track crossing sensor, the fine home sensor, and the carriage photocell. The signals 'track crossing', 'fine home area', and 'coarse home' are logically ANDed to give the line 'home'.

The read/write heads can only load at track 000 and move there prior to head loading during the machine start-up sequence. Under normal circumstances, the home detection logic prevents the carriage from retracting behind track 000.

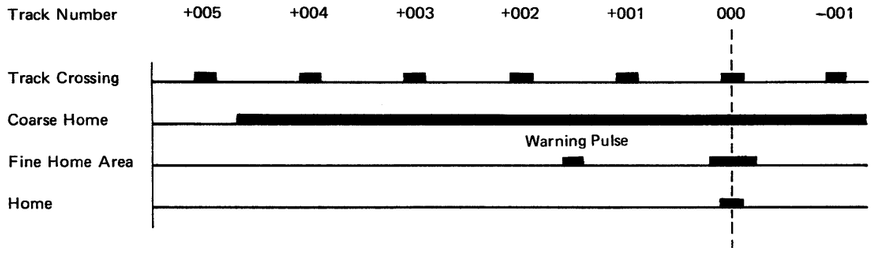


Figure 1-38. Track 000 Indication [07498]

DATA CHANNEL ELECTRONICS

- **Contains circuits for read and write operations**
- **Contains safety circuits to protect recorded data.**

The data channel contains the circuits required to enable the read/write heads to write information onto the recording disks, or to read information from the disks. The data channel also contains safety circuits to ensure that read and write operations take place only when it is safe to do so. Separate head select circuits are used for the read and write operations.

The data channel circuits are contained in four SLT cards, three of which are mounted in a 2 x 14 SLT board (see Figure 1-29). The fourth card (matrix and preamplifier) is mounted in the preamplifier enclosure.

COMMUNICATION LINES

- **A total of 23 communication lines are connected between the 5444 and the using system (Figure 1-39).**
- **12 input lines supply signals to the 5444 from the system control circuits.**
- **8 output lines supply signals from the 5444 to the system control circuits.**
- **3 additional lines are available for timing analysis programs (TAP's).**

The machine operations are controlled by command signals from the using system via input communication lines. Output communication lines provide machine status information to the using system, indicating that the machine is conditioned to respond to the system command signals.

The signal levels referred to in this section correspond to the standard SLD-100 logic levels, as follows:

Up level: +3.0V dc to +6.6V dc.
Down level: 0V dc to +0.3V dc.
Note: The voltages are measured at the machine/system interface.

All signal lines connect to the 5444 via three half-wide tape cables that plug into the 2 x 14-SLT board mounted in the logic gate at the front of the machine (see Figure 1-29).
Note: The 5444 derives power from the using system.

Input Communication Lines

- **The 12 input lines condition the 5444 for the read/write operations.**
- **The lines also provide the command signals to control these functions.**

'Read Select': Activated at a down level and gated with the 'disk select' and 'head select' lines to select the read/write head defined by these lines for a read operation. Read signals from the selected head are then fed to the read amplifier circuits. 'Read select' may not be activated in the following circumstances:

1. During the head settling time following an access operation.
2. Until at least 5μs after the disk select lines are switched.
3. Following a write operation, until at least 1.2μs after 'erase select' is dropped.

'Disk Select Upper' and 'Disk Select Lower': These two lines define which disk is to be used for read or write operations. Each line is activated by a down level. An up level on both lines deselects both disks; a down (active) level on both lines is an unsafe condition when 'write select' is activated. The lines may not be switched under the following circumstances:

1. Following a write operation, until at least 1μs after 'erase select' is dropped.
2. Following a read operation, until at least 1μs after 'read select' is dropped.

'Head Select Upper' and 'Head Select Lower': These two lines define which read/write head is to be used for read or write operations on the disk defined by the disk select lines. The operating levels and switching conditions for the head select lines are the same as those for the disk select lines.

'Double Frequency Write Data': Carries the input write data to the 5444 and drives the 5444 write trigger. The leading edge of each pulse on the 'double frequency write data' line causes a magnetic flux reversal to be recorded on the selected disk surface. The line carries clock pulses interspersed with data pulses. When 'write select' is activated, the first pulse occurs on the 'double frequency write data' line within 315 ns. 'Write select' drops 315 ns after the leading edge of the last pulse.

'Erase Select': Activated at a down level and gated with the disk and head select lines to select the head for a write (and erase) operation. Erase current flows in the erase coil (during a write operation, the erase coil is energized as well as the write coil). 'Erase select' is activated within 1μs of 'write select', and dropped 24μs after 'write select' is dropped. Following a read operation, 'erase select' is not activated until at least 1.2μs after 'read select' is dropped.

'Write Select': Activated at a down level; write current is turned on in the write coil provided that 'erase select' is also activated. Data on the 'double frequency write data' line is then written onto the selected disk surface. Write operations are inhibited when the 5444 is off-line and

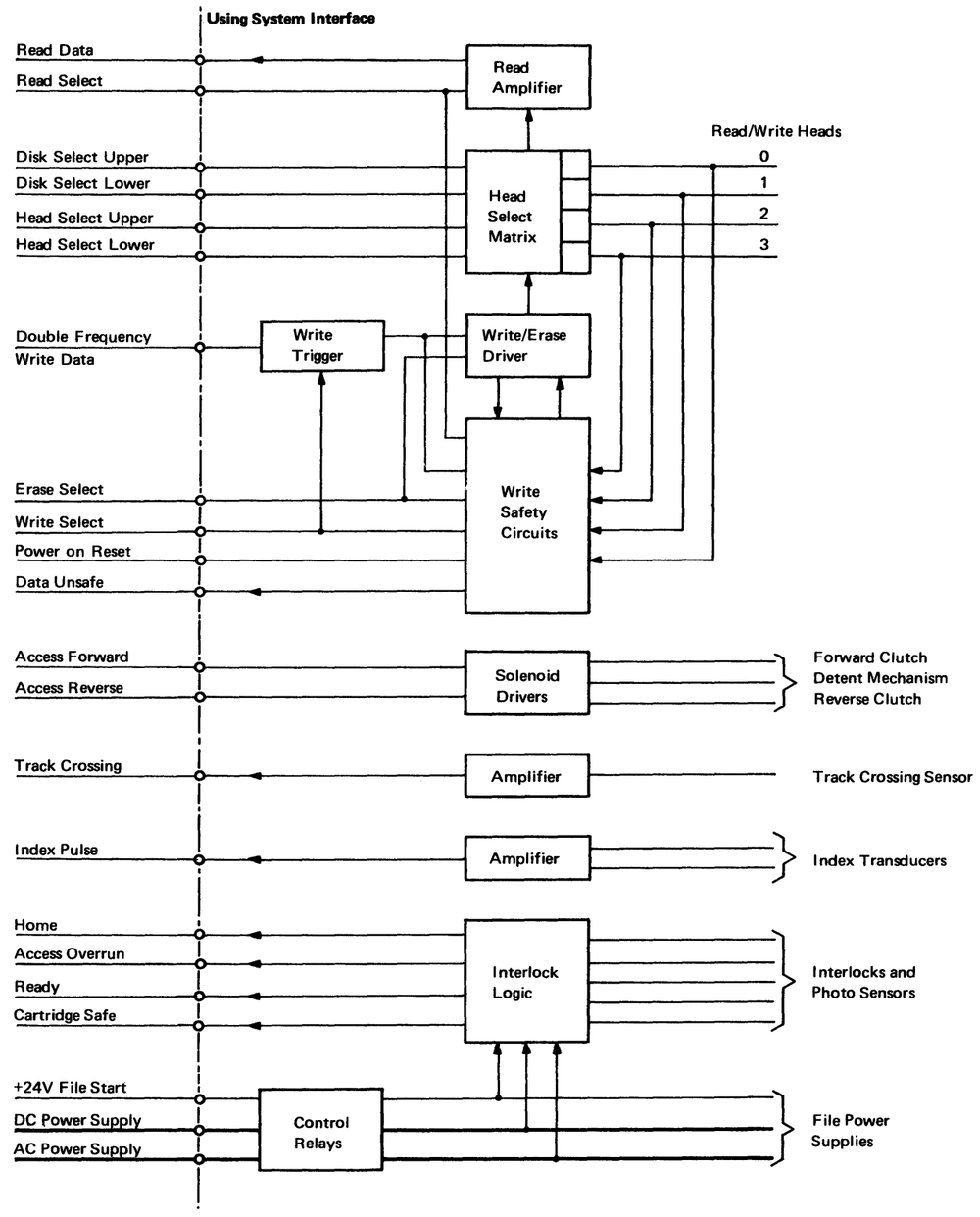


Figure 1-39. Data Flow and Control [07499]

under control of CE control panel. The 'write select' line is activated within 1 μs of 'erase select' and may not be activated under the following circumstances:

1. During the head settling time following a head movement.
2. Until at least 5 μs after the disk select and head select lines are switched.
3. Following a read operation, until at least 1.2 μs after 'read select' is dropped.

'Power On Reset': Resets the machine safety latches when the using system dc supply is first switched on and provides the internal line 'data unsafe reset' to reset the three safety latches. The line switches to a down level for 1 ms.

'Access Forward': Activated at a down level and releases the detent mechanism, allowing the carriage to move. The forward clutch is then energized, moving the carriage (and read/write heads) forwards, toward the disk center. 'Access forward' must not be activated at the same time as 'access reverse'.

'Access Reverse': Activated at a down level, releasing the detent mechanism and allowing the carriage to move. The reverse clutch energizes, moving the carriage backwards, away from the disk center. 'Access reverse' must not be activated at the same time as 'access forward'.

'+24V File Start': Activated when switched to +24V dc. The line controls ac power to the drive motor and initiates the start-up sequence. The cartridge interlocks (operated by the cartridge clamp arms) are connected in series with the '+24V file start' line. These interlocks drop '+24V file start' to prevent start-up sequence if the cartridge is not in position on the machine.

Output Communication Lines

- **The eight output lines provide machine status information to the using system.**

'Read Data': Carries clock pulses interspersed with data pulses from the read amplifier circuits. Each 100 ns pulse corresponds to a magnetic flux reversal on the disk surface. (The up level depends on the type of data separator used by the using system.)

'Data Unsafe': Activated at an up level to indicate an unsafe condition in the 5444. Three safety latches detect unsafe conditions in the write circuits during read/write operations. Further read/write operations are then inhibited.

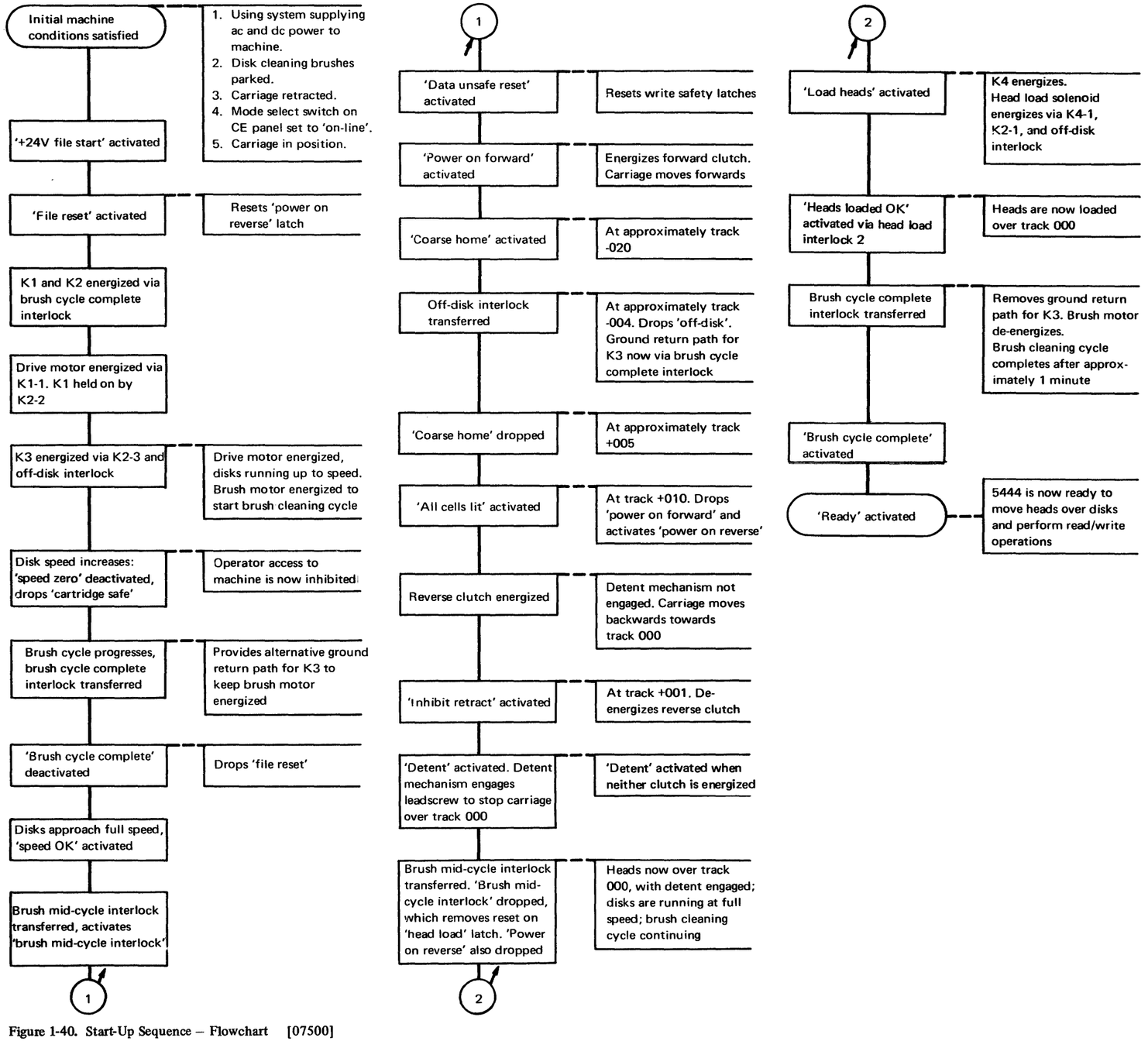


Figure 1-40. Start-Up Sequence – Flowchart [07500]

'Track Crossing': The positive-going edge of each pulse indicates each track crossed by the read/write heads. The pulses are obtained from the track crossing photocell and give the using system a continuous indication of read/write head position. When the carriage starts to move, a 1.5 ms positive-going pulse indicates the first track crossed; subsequent pulses have a pulse width of approximately 1 ms at 3.5 ms intervals. The pulses are at up level while the heads cross the tracks, but are at down level when the heads are stationary over a track.
Note: To stop the carriage, 'access forward' or 'access reverse' drop within 10μs after the positive-going edge of the last track crossing pulse.

'Index Pulse': Carries 43μs positive-going index pulses indicating the start of each recording track. After amplification, the output from either the upper or lower index transducers is selected by the 'disk select upper' line or the 'disk select lower' line. When neither disk select line is activated, the lower transducer output is available on the 'index pulse' line.

'Home': Indicates that the read/write heads are positioned over track 000. The line is activated at a down level when the lines 'fine home area', 'track crossing', and 'coarse home' are ANDed together, and when the forward clutch is not selected.

'Access Overrun': Indicates that the carriage has incorrectly moved beyond its inner limit of travel, that is, beyond track 103 for Model 1 and beyond track 203 for Models 2 and 3. The line is activated at a down level.

'Ready': Activated at a down level under the following conditions indicating that the 5444 is ready:
1. Start-up delay time expired and brush cleaning cycle complete.
2. Disks running at full speed.
3. Heads loaded at track 000.
4. CE mode select switch set to 'on-line'.

During normal operations, 'ready' remains down, but rises if any one of the following conditions occurs:
1. AC power fails.
2. Disk speed drops to an unsafe level (below 960 rpm).
3. Heads unloaded.
4. An unsafe condition exists (indicated by 'data unsafe' line).

'Cartridge Safe': Activated at down level to indicate when the operator can gain access to the machine and the disk cartridge. The following lines are required to give 'cartridge safe':
1. 'Brush cycle complete'.
2. Not 'head loaded OK'.
3. 'Speed zero'.
4. Not 'speed OK'.
5. 'Carriage retracted'.
6. 'Off disk'.

MACHINE OPERATIONS

- **Machine operations are controlled by command signals from the using system.**
- **Movement of heads over the disks is controlled by 'access forward' and 'access reverse'.**
- **Start/stop sequencing is controlled by '+24V file start'.**

Machine Safety

The following safety devices are incorporated on the 5444:
1. Two mechanical drawer stops: prevent the 5444 being moved into its enclosure with the cartridge clamp arms open.
2. Two cartridge interlock switches: prevent machine start-up if the cartridge clamp arms are open.
3. 80% speed detector circuit: indicates when the disk rotation speed has fallen to an unsafe level.
4. Off-disk interlock switch: unloads the heads if the carriage is retracted past track -004.
5. Knock-off mechanism: mechanically unloads the heads before they reach the disk edge (a backup to the off-disk interlock switch).
6. Head load interlock switch 2: indicates that the heads are loaded.
7. Carriage overrun interlock switch: prevents carriage travel past the inner limit.
8. Carriage retracted interlock switch: stops carriage travel at the retracted position.

Start-Up Sequence

- **Initiated when '+24V file start' is activated.**
- **The purpose is to allow time for the disk cleaning cycle to complete, the electronics to stabilize, and the disk enclosure temperature to stabilize.**
- **Takes approximately 1 minute to complete.**
- **When complete, activates 'ready' line, and machine can perform operations under control of the using system.**

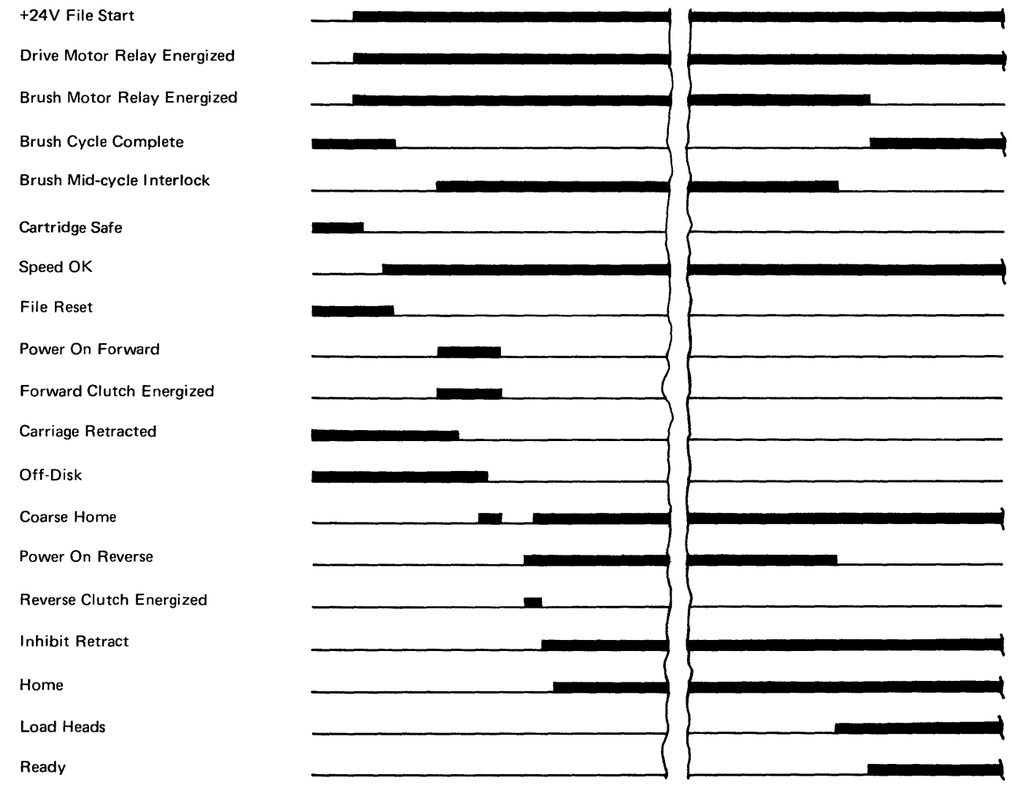


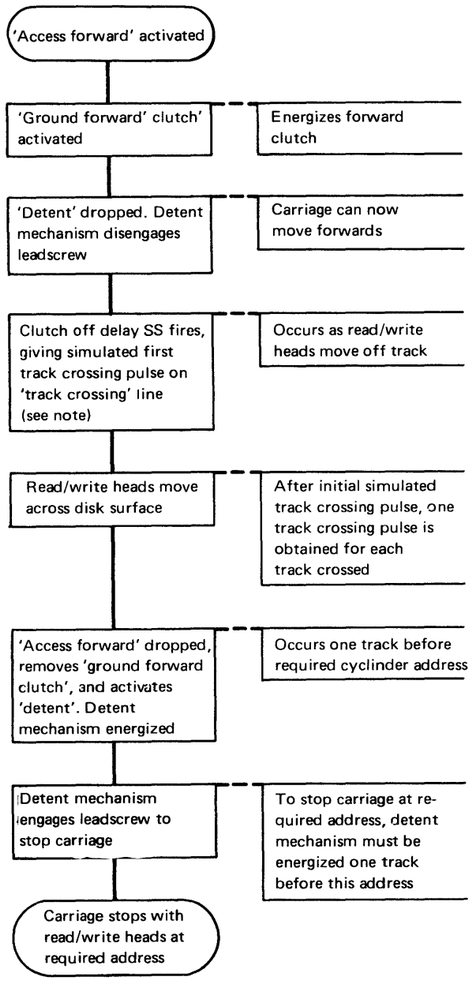
Figure 1-41. Start-Up Sequence – Timing [07502]

- **The sequence is shown in Figure 1-40.**
- **Timing is given in Figure 1-41.**

Head Movement Across Disks

- **Controlled by command signals from the using system.**
- **These commands are 'access forward' and 'access reverse'.**
- **If heads move to wrong location, the using system may use a recalibration operation to reset the read/write heads to a known track position, for example, track 000.**
- **During maintenance, the CE can control the 5444 from the CE control panel.**

Movement of heads cannot begin until 'ready' is activated, that is, the following conditions are satisfied:
1. Disks are running at full speed.
2. Heads loaded over the disks.
3. No write unsafe condition exists.
4. Mode select switch on the CE control panel set to 'on-line'.



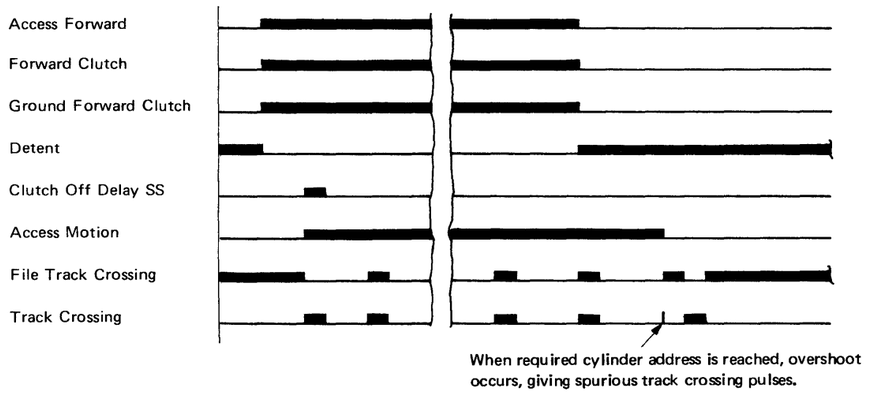
Note: The simulated track crossing pulse is an extra pulse which is required because the detent mechanism takes one track to operate; without this extra pulse the carriage would stop at the wrong track.

Figure 1-42. Multiple Track Head Movement – Operation Sequence [07503]

'Access Forward'

- **Sequence is given in Figure 1-42.**
- **Timing is given in Figure 1-43.**
- **Derivation of clutch and control signals are shown in Figures 1-44 and 1-45.**

MULTIPLE TRACK



SINGLE TRACK

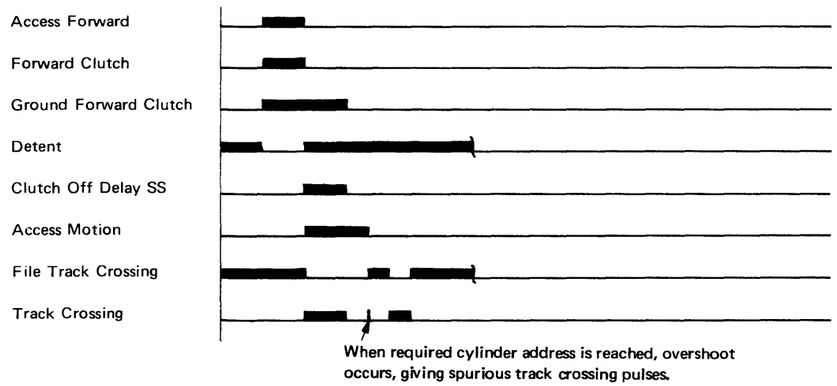


Figure 1-43. Head Forward Operation – Timing [07504]

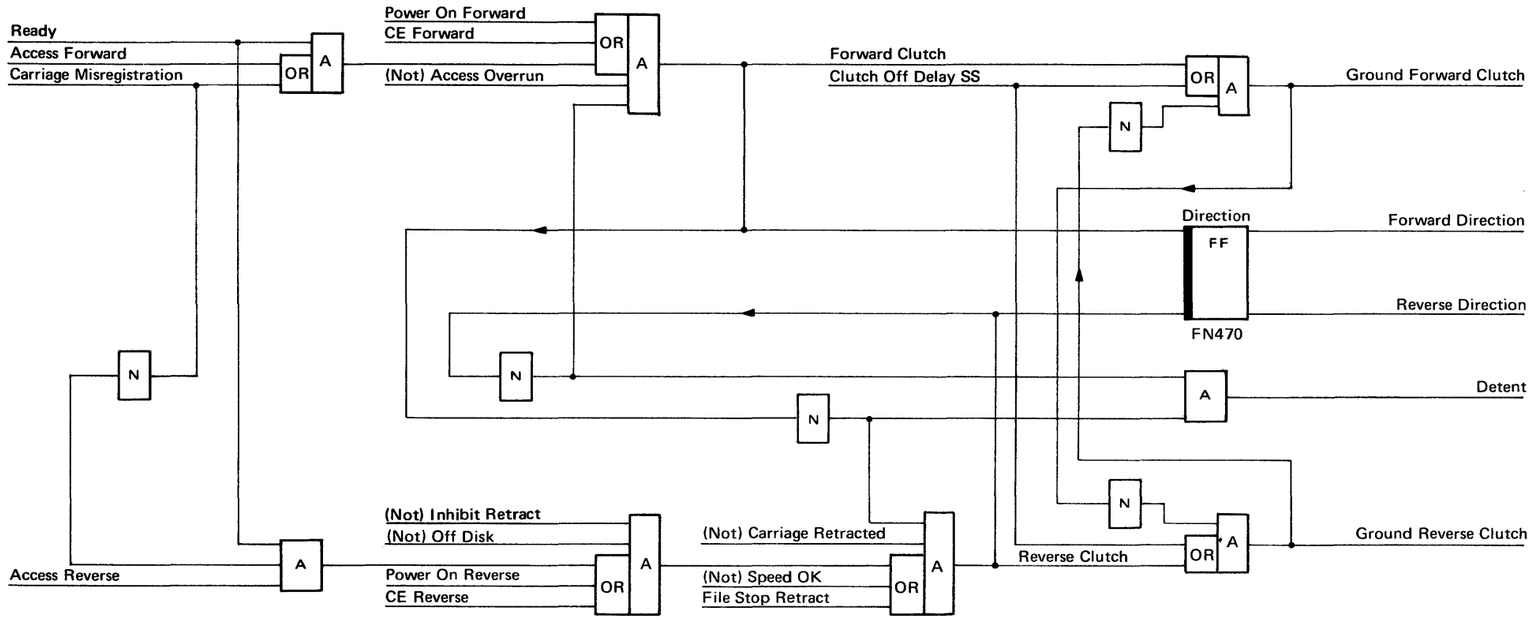


Figure 1-44. Clutch and Detent Signals [07505]

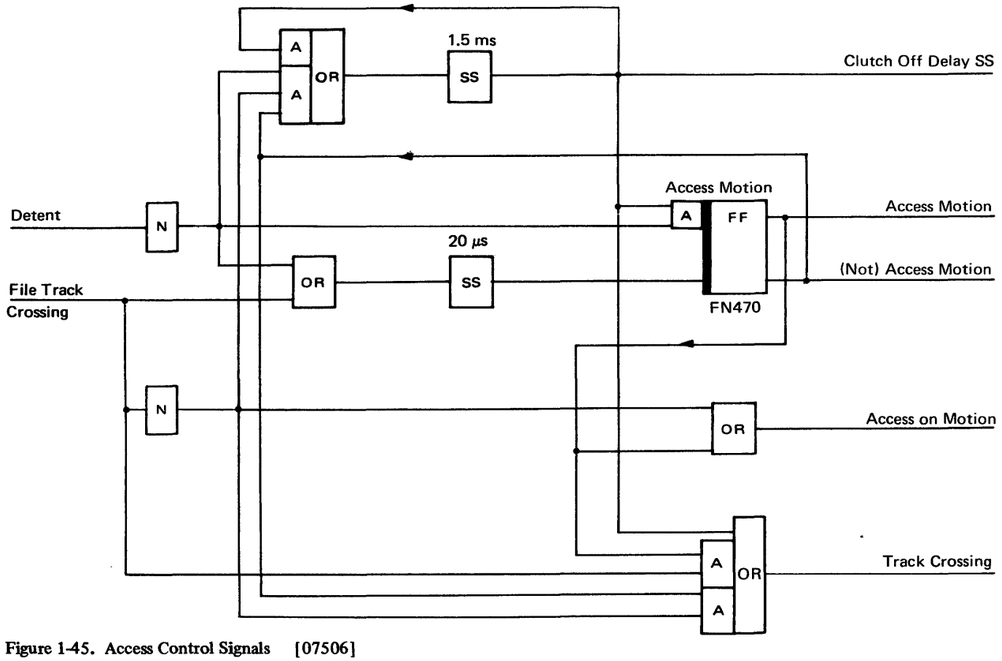


Figure 1-45. Access Control Signals [07506]

Single Track Accessing

- **The sequence is shown in Figure 1-46.**
- **See Figures 1-43, 1-44, and 1-45 for timing and logic.**

'Access Reverse'

- **Similar to 'access forward'.**

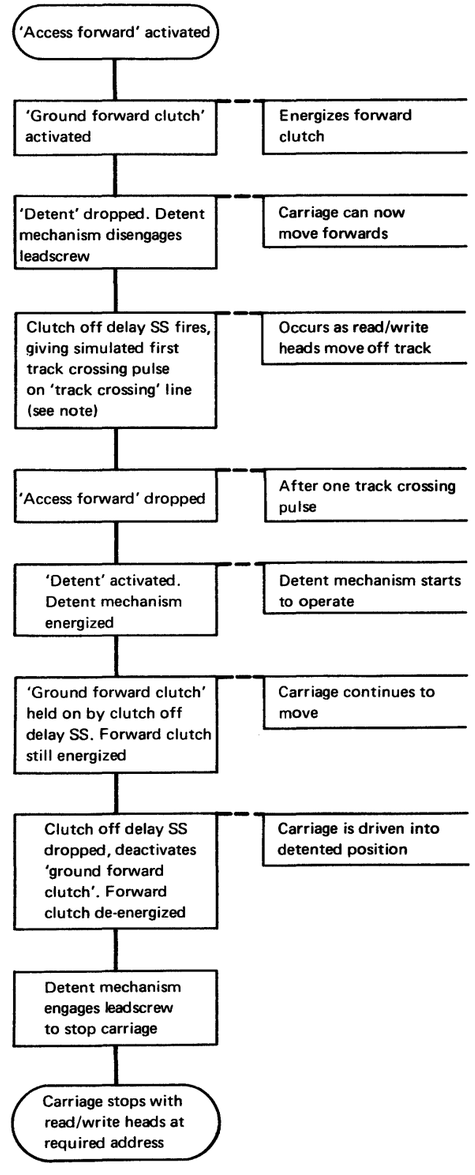
Recalibration to Track 000

- **If the head movement is at error, the using system may perform a recalibration operation.**

The using system requires to know the cylinder address of the read/write heads at all times. The correct cylinder address, however, could be lost because of one of the following reasons:

1. Wrong track address (heads stop on the wrong track).
2. Misregistration (heads stop between tracks).
3. Carriage overrun (heads move as far as the carriage overrun interlock).

If the cylinder address is lost, the using system may start a recalibration operation to return the read/write heads to track 000; the 5444 contains the logic circuits used for the recalibration. To start a recalibration operation, 'access reverse' is activated.



Note: The simulated track crossing pulse is an extra pulse which is required because the detent mechanism takes one track to operate; without this extra pulse the carriage would stop at the wrong track.

Figure 1-46. Single Track Head Movement – Operation Sequence [07507]

Recalibration After Wrong Track Address

From Tracks 002 to 202: When 'access reverse' is activated, the carriage retracts towards track 000. At approximately track 001.5, the fine home area warning pulse occurs, setting the 'home area' latch (Figure 1-47). With the 'home area' latch set, the 'inhibit retract' latch is set by the track crossing pulse at the next track crossing point (track 001). With 'inhibit retract' activated, 'ground reverse clutch' is dropped, and 'detent' activated (see Figure 1-44). ('Detent' must be activated one track before track 000.) The carriage stops with the heads at track 000 and 'access reverse' is dropped.

From Track 001: Recalibration from track 001 is slightly different because no fine home warning pulse occurs to set the 'home area' latch. The 'inhibit retract' latch is now set by the first track crossing pulse (derived from the clutch off delay SS and obtained as the heads move off track 001). 'Detent' is therefore activated one track before track 000. As for a single track accessing, 'ground reverse clutch' is held on by the clutch off delay SS, to ensure that the carriage has sufficient momentum to move one track.

Recalibration After Misregistration

- **The recalibration operation varies, depending on whether or not misregistration occurs in the add write current area.**
- **Figure 1-48 shows the head movement error logic.**

Between Tracks -000.5 and +005: When 'access reverse' is activated, an SS is fired, the output of which is ANDed with not 'file track crossing' to set the 'carriage misregistration' latch. 'Carriage misregistration' inhibits 'access reverse' and activates 'ground forward clutch', to move the carriage forwards until the 'carriage misregistration' latch is reset by 'carriage pc lit' at approximately track +005. 'Carriage misregistration' drops and deactivates 'ground forward clutch'; 'access reverse' is no longer inhibited. The carriage can now retract to bring the read/write heads to track 000. The home detection logic stops the carriage at track 000.

Between Tracks +005 and +202: In this area either 'carriage pc lit' or 'add write current' lines holds the 'carriage misregistration' latch reset. 'Access reverse' is activated, bringing up 'ground reverse clutch' to retract the carriage to track 000.

Recalibration After Carriage Overrun

The carriage overrun interlock is set as follows:
1. Beyond track 103 for Model 1.
2. Beyond track 203 for Models 2 and 3.

If the carriage moves as far as to transfer the carriage overrun interlock switch, activating 'access overrun', the +24V dc driver supply to the forward clutch is broken, and 'ground forward clutch' is dropped, preventing any further forward movement. 'Access reverse' is then activated to retract the heads to track 000. The home detection logic stops the carriage at track 000.

CE Access Operations

- **The CE can control the 5444 from the CE control panel.**
- **The CE controls the heads movement by using the mode select switch and the forward/reverse switch.**
- **Figure 1-49 shows the CE control logic.**

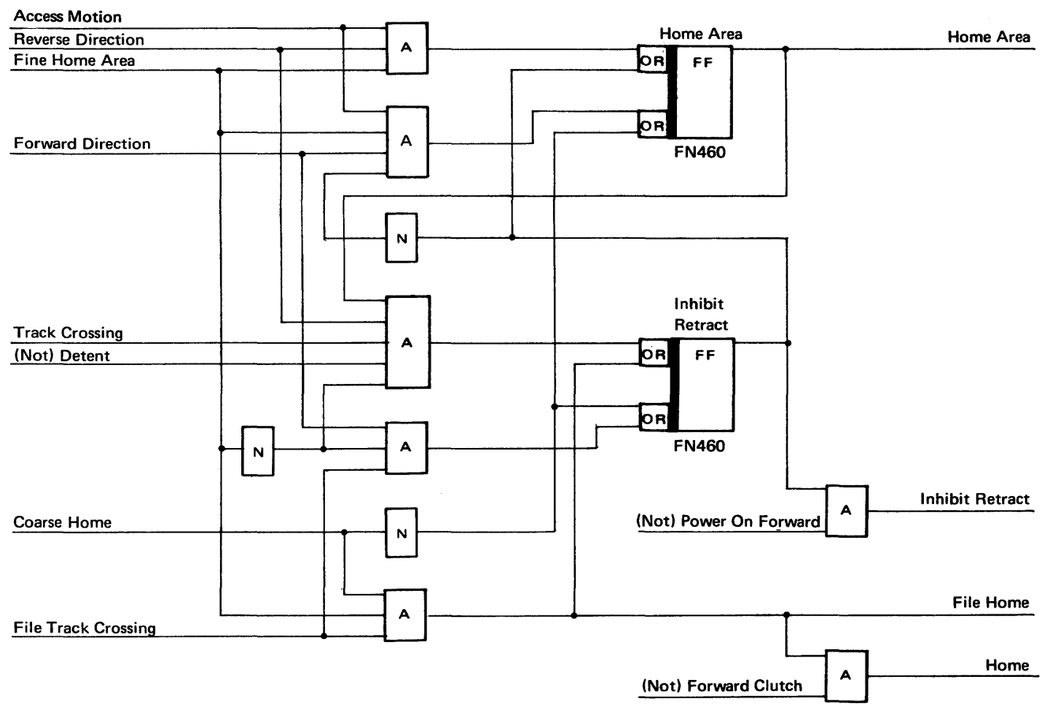


Figure 1-47. Home Detection Logic [07508]

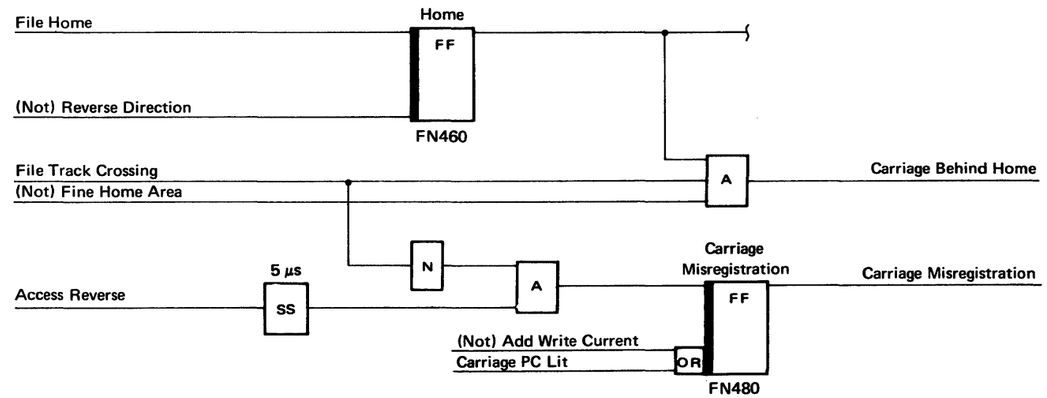


Figure 1-48. Head Movement Error Logic [07509]

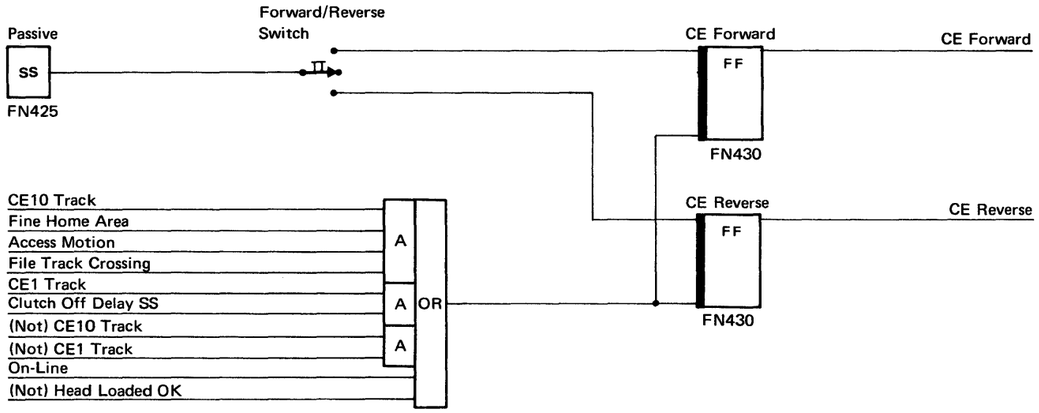


Figure 1-49. CE Control Logic [07510]

While the 5444 is controlled from the CE control panel, 'on-line' is dropped, deactivating 'ready'; the machine is then automatically *read-select and write-inhibited.* The heads can be moved in steps of one or 10 tracks at a time as selected on the mode select switch.

One-track and 10-track operations are similar for forward and reverse direction. In the following paragraphs only the forward direction is described.

One-Track Forward Access

When the forward/reverse switch is set to FORWARD, a singleshot fires, setting the 'CE forward' latch. 'CE forward' is activated, bringing up 'ground forward clutch', and dropping 'detent' (see Figure 1-44).

The carriage now moves forwards and as it moves off-track the clutch off delay SS fires to reset the 'CE forward' latch; 'CE forward' is dropped, and 'detent' activated. The detent mechanism engages to stop the carriage after one track.

10-Track Forward Access

When the forward/reverse switch is set to FORWARD, a singleshot fires, setting the 'CE forward' latch. 'CE forward' is activated, bringing up 'ground forward clutch', and dropping 'detent'. The carriage moves forward towards the next 10-track position (that is, track 010, 020, and so on). As it reaches the tenth track 'fine home area' and 'file track crossing' are activated, resetting the latch. 'Ground forward clutch' is dropped, and 'detent' activated. The detent mechanism engages to stop the carriage one track later. During a forward operation, the carriage stops at tracks 011, 021, 031, and so on. During a reverse operation, the carriage stops at tracks 039, 029, 019, and so on.

Machine Stop Sequence

- **Initiated when '+24V file start' drops.**
- **When the sequence is complete, the machine can be opened to remove the disk cartridge.**
- **DC braking reduces the machine stop sequence time to approximately 30 seconds.**
- **The machine stop sequence is shown in Figure 1-50.**
- **The machine stop logic and timing are given in Figures 1-51 and 1-52.**
- **See Figure 1-47 for home detection logic.**

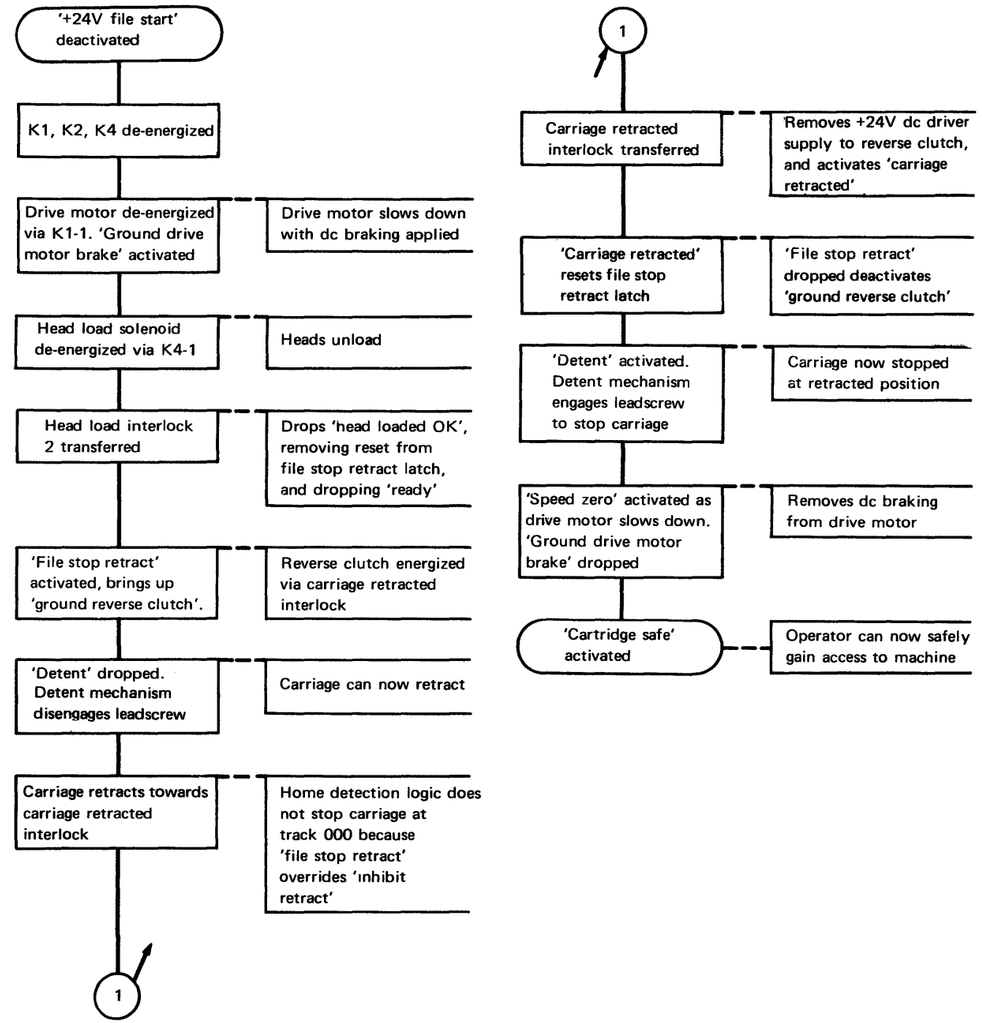


Figure 1-50. Machine Stop Sequence [07511]

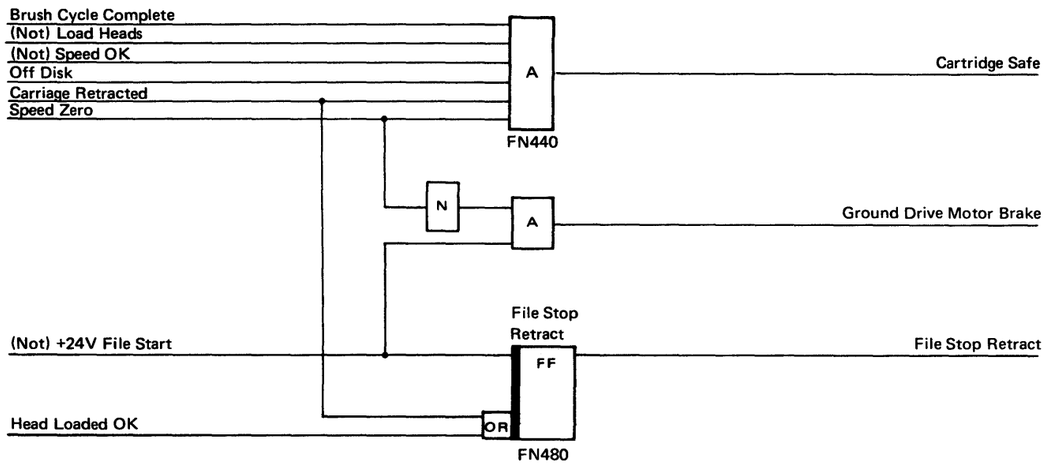


Figure 1-51. Machine Stop Logic [07512]

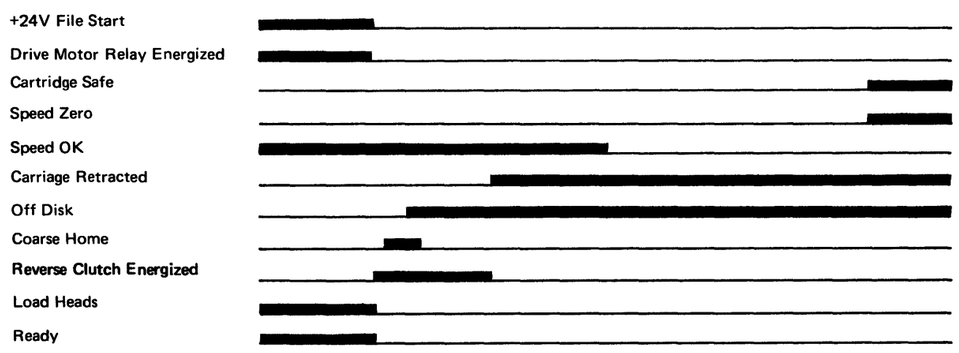


Figure 1-52. Machine Stop Timing [07513]

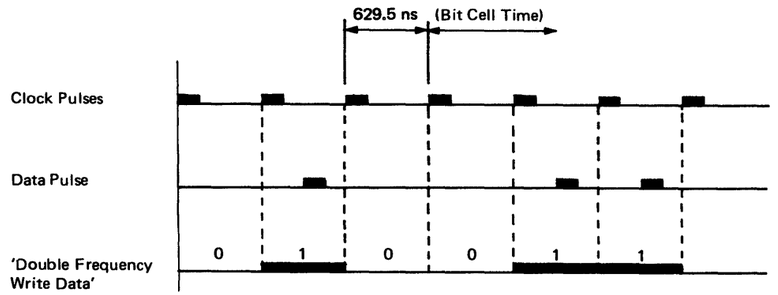


Figure 1-53. Derivation of Composite Write Signal [07514]

When the machine stop sequence is complete, the heads mechanically unload, the carriage retracts, and the disks stop. (The heads must be retracted off the disks to prevent damage while removing or installing a cartridge.) 'Cartridge safe' is activated, allowing customer access to the machine to remove the disk cartridge.

When '+24V file start' drops, all other ac and dc power supplies remain on at the machine. Note that ac power is still present at the ac box. If '+24V file start' drops within one minute of being activated (that is, during a machine start-up sequence), the start-up sequence must complete before 'cartridge safe' is activated; this allows the disk brushes to park.

READ/WRITE OPERATIONS

- **Read/write operations are controlled by the using system.**
- **The 5444 uses the double-frequency horizontal non-return to zero (NRZ) recording method.**
- **During a write operation, a data bit is recorded on the disk surface when the current in the head coils is reversed.**
- **During a read operation, a bit is sensed when there is a flux reversal on the disk surface.**

Double Frequency Recording

- **The using system clock frequency produces the basic bit-cell timing cycle.**
- **Clock pulses are synchronized with interspersed data pulses to produce a single composite write signal.**
- **The write signal presents either a zero-bit condition or a one-bit condition for each bit-cell time generated by the clock.**

The 5444 uses the double frequency horizontal NRZ method of magnetic recording. Data pulses intersperse with clock pulses from the using system to produce a write signal on the 'double frequency write data' line (Figure 1-53).

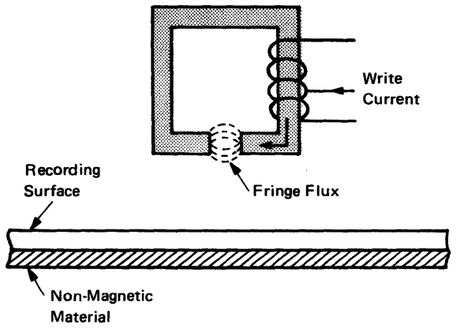


Figure 1-54. Basic Read/Write Head [07515]

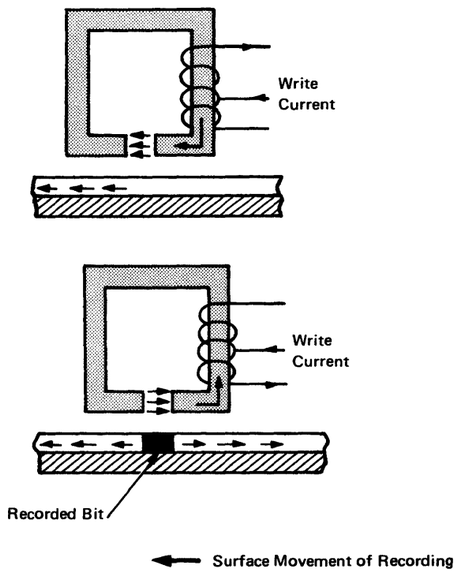


Figure 1-55. Horizontal Recording [07516]

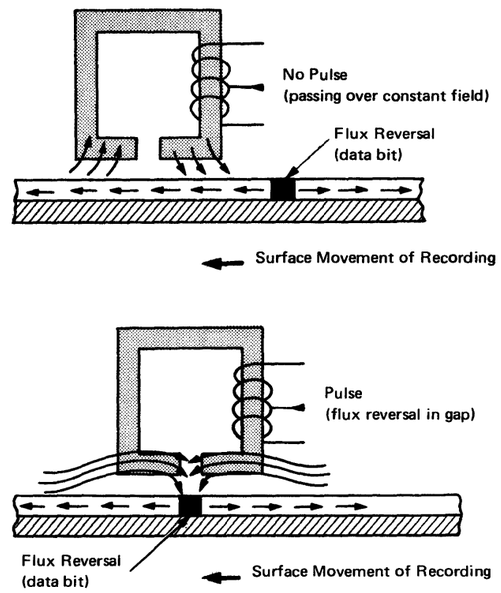


Figure 1-56. Horizontal Reading [07517]

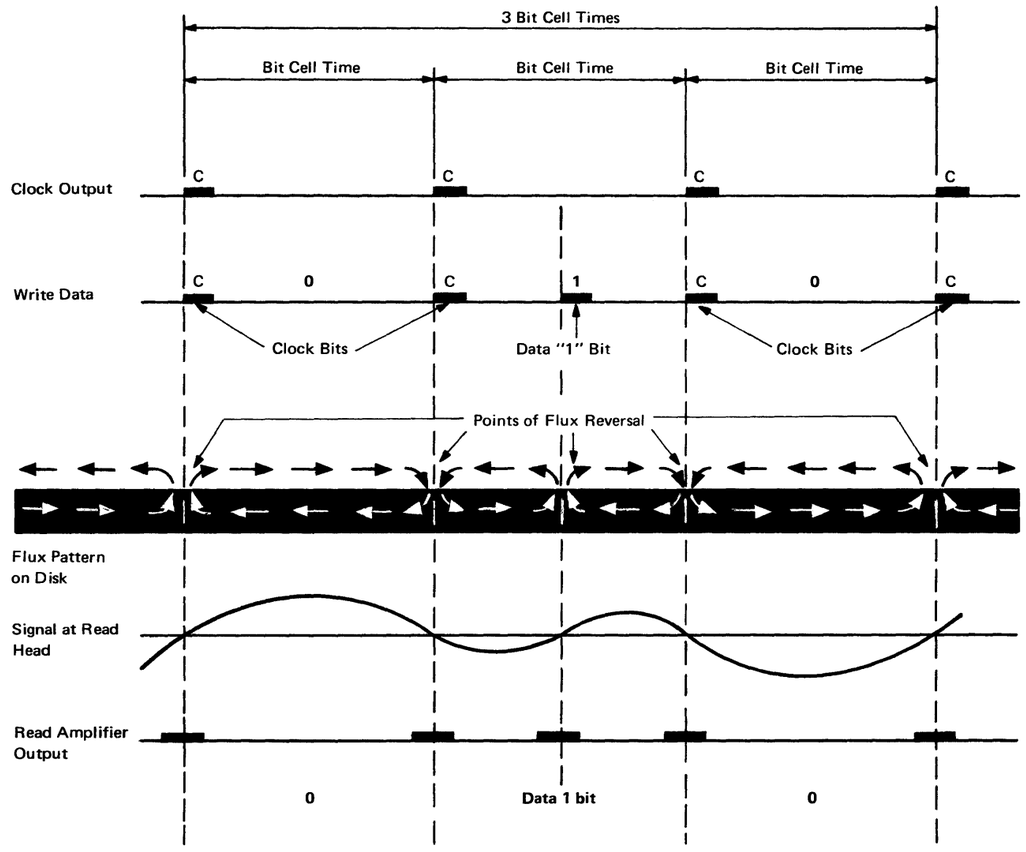


Figure 1-57. Double Frequency Recording – Flux and Pulse Relationship [07518]

The recording device is a read/write head, diagrammatically represented in Figure 1-54. When current flows, the flux induced in the pole piece fringes at the gap. As the magnetic recording surface passes, the fringe flux horizontally magnetizes the surface.

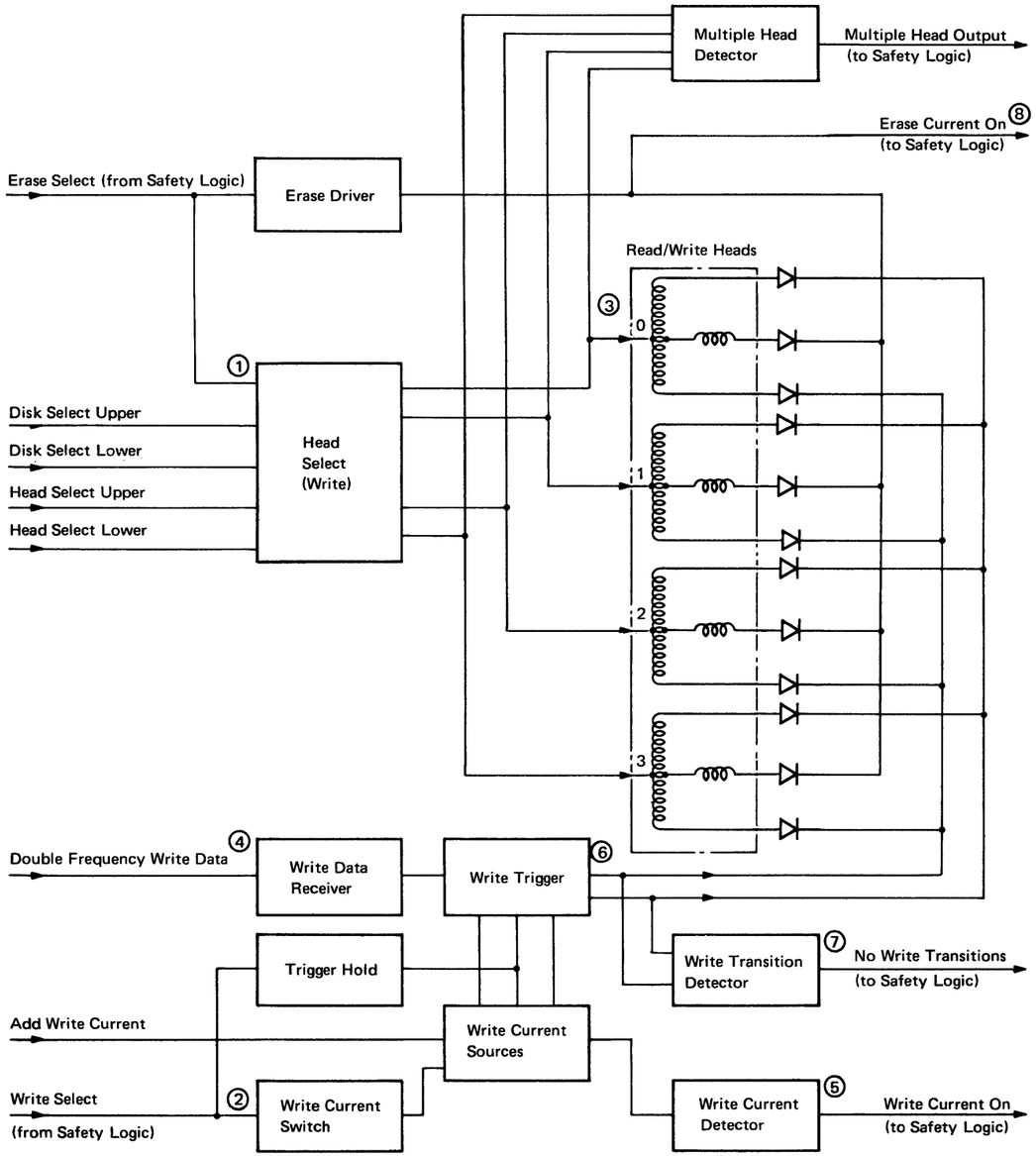
During a write operation, a data bit is recorded by reversing the direction of the current in the coil, which reverses the flux direction in the pole piece and reverses the fringe flux in the gap. At the instant the flux in the pole piece gap reverses, the direction of magnetization changes on the disk surface. Each reversal between clock pulses represents a recorded data bit (Figure 1-55).

During a read operation, with recording surface magnetized in one horizontal direction, constant flux flows and the coil registers no output voltage (Figure 1-56). However, when the recorded bit (180 degrees horizontal flux reversal) passes the gap, the flux flowing through the ring and coil also reverses and produces a voltage output pulse. The flux and pulse relationship of the double frequency recording is given in Figure 1-57.

Write Operation

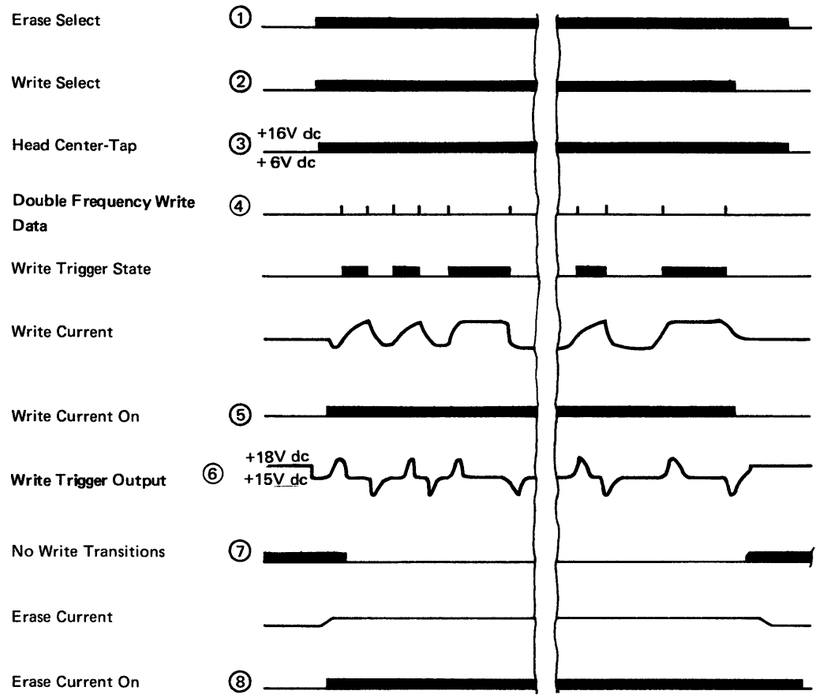
- **Write operations are controlled by command signals from the using system.**
- **Data to be recorded enters the 5444 on the 'double frequency write data' line.**
- **The required read/write head is defined by the head select and disk select lines.**
- **Write and erase circuits are then activated by 'write select' and 'erase select'.**

For each clock or data bit that arrives on the 'double frequency write data' line, the write current switches to the other half of the read/write coil (see Figure 1-55). The flux at the read/write gap is reversed, to record the bit on the selected disk surface.



Note: Circled numbers refer to Write Circuit waveforms (Figure 1-59)

Figure 1-58. Write Circuit – Logic [07519]



Note: Waveform numbers refer to Write Circuit Logic (Figure 1-58)

Figure 1-59. Write Circuit – Waveforms [07520]

Write operations end when the flow of clock and data bits ceases. 'Write select' (refer to "Input Communication Lines") then drops, turning off the write current in the read/write coil. 'Erase select' drops 25μs after 'write select', ensuring that the newly written track is 'side' erased right up to the end of the data.
Note: Write operation is inhibited when the 5444 is controlled from the CE control panel.

Write Circuits

The write circuits consist of head select circuits, and write and erase drivers (Figure 1-58). Timing waveforms are given in Figure 1-59.

Head selection for a write operation is achieved by switching the center-tap of the selected read/write coil to +16V dc. The center-taps of the read/write coils in the three non-selected heads are left floating.

Write current is turned on when 'write select' is activated and is switched between the two halves of the read/write coil by the write trigger, which switches every time a clock or data bit is received on the 'double frequency write data' line. The write current is 35 mA (nominal) for tracks 000 to +115, and 30 mA (nominal) for tracks 116 to 203. This current level is controlled by the 'add write current' line.

Read Operation

- **Read operations are controlled by command signals from the using system.**
- **Data read from the disk surfaces is passed to the using system on the 'read data' line.**
- **The required read/write head is defined by the head select and disk select lines.**
- **Read circuits are then activated by 'read select'.**

The read circuits are activated as long as 'read select' remains up. Read signals read off the selected disk by the read/write head, are amplified and shaped in the read circuits. The raw data output from the read circuits is fed via the 'read data' line to the using system where a data separator separates the raw data into data bits and clock bits.

Note: The 5444 may also be used for read operations when off-line, and controlled from the CE control panel. The appropriate read/write head is selected by one of four CE head select lines. 'Read select' is not required.

Read Circuits

The read circuits consist of head select circuits, preamplifier, filter, limiter and detector circuits (Figure 1-60). Timing waveforms are given in Figure 1-61. The read circuits produce a train of pulses representing the magnetic patterns recorded on the disk surface. The bit-cell period is nominally 629.5 ns. Individual bit-cell periods can vary by ±22% because of interaction between adjacent magnetic patterns recorded on the disk surface. Variation may occur in the relationship between the data and clock pulses due to this interaction. This effect is called bit shift and is kept to a minimum (see Figure 1-61).

During a read operation, the center-taps of all the read/write heads are left floating. Head selection is achieved by taking the center-tap of the read/write coil load resistor to 0V dc. The center-taps of the non-selected heads are at +5V dc.

Safety Circuits

- **Detect unsafe conditions in the write circuits.**
- **Inhibit read/write operations when conditions are unsafe.**
- **On the write select and safety SLT card.**

The 5444 contains safety circuits to protect data recorded on the disk. Four outputs from the write circuits are compared with 'write select', 'erase select', 'read select', and 'access in motion' to determine whether an unsafe condition exists. If an unsafe condition does exist, one of three latches is set, activating 'data unsafe'; the heads mechanically unload and 'ready' drops inhibiting all further read or write operations.

The three latches, together with the conditions that set the latches, are as follows:

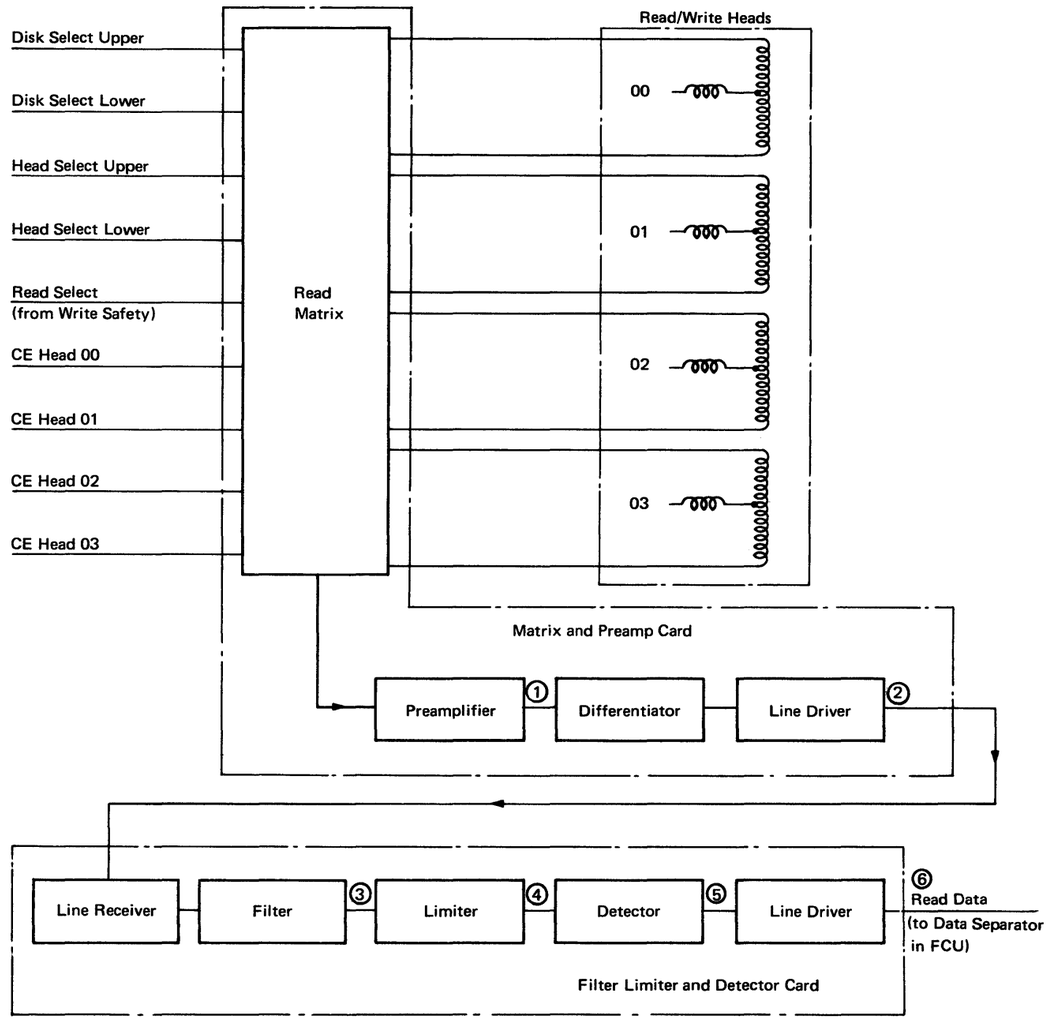
Select unsafe latch:
1. 'Read select' activated, together with either 'write select' or 'erase select'.
2. 'Access in motion' activated, together with either 'write select' or 'erase select'.

Erase Unsafe Latch:
1. 'Write select' activated, with 'erase current on' dropped.
2. 'Write select' dropped, with 'erase current on' activated.

Write Unsafe Latch:
1. 'Write select' activated, with 'no write transitions' activated.
2. 'Write select' dropped, with 'write current on' activated.
3. 'Write select' activated, with 'multi head output' activated.

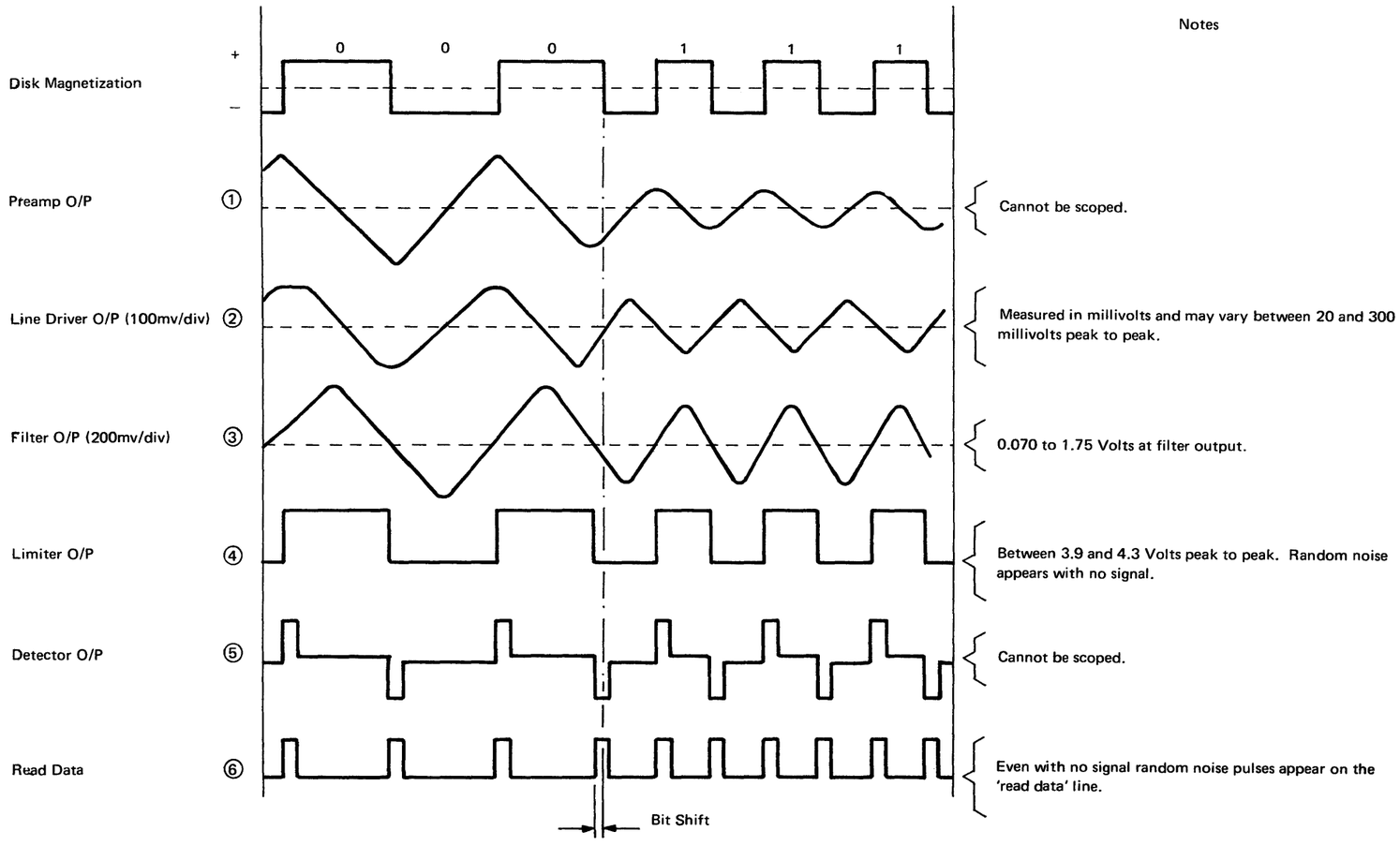
The latches are reset on machine start up, the line 'brush midcycle interlock' raising 'data unsafe reset'. If the unsafe condition is removed, read/write operations can resume.

When the using system powers up, the latches are reset by 'power on reset' raising 'data unsafe reset'.



Note:
1. Circled numbers refer to Read Circuit Waveforms (Figure 1-61).
2. Waveforms marked thus * cannot be scoped.

Figure 1-60. Read Circuit – Logic [07521]



Notes:
1. Waveform numbers refer to read circuits. See Figure 1-60.
2. Voltage amplitude values are differential.

Figure 1-61. Read Circuit – Waveforms [07522]

Chapter 4. Features

There are no features applicable to this machine.

POWER REQUIREMENTS

- **All power supplies are obtained from the using system.**
- **The 5444 can be operated from 50 Hz or 60 Hz power supplies. Differences between machine versions are given in Appendix B.**
- **The input power lines are shown in Figure 1-62.**

AC Power

The ac power requirements are as follows:
220/235V ac ±10%, 50 Hz ±0.5 hz, single phase
or
208/230V ac ±10%, 60 Hz ±0.5 Hz, single phase
Surge current (starting): 3.5A rms maximum
Average current: 1A rms maximum
AC ground is connected as a separate line to the using system; the AC box is connected to ac ground and is insulated from the machine base.

DC Power

The following dc power supplies are required:
+24V dc ±10%, 'file start' line, maximum current 0.2A
+24V dc ±10%, driver supply, maximum current 6.0A
+24V dc ±10%, regulator supply, maximum current 0.65A
+6V dc ±8%, maximum current 1.0A
-4V dc ±8%, maximum current 1.3A
-30V dc +6.1V, -5.1V, maximum current 0.35A
Two lines are required for the +24V dc input: a +24V regulator line, and a +24V driver line. The regulator line is used to supply the +18V dc voltage regulator. The driver line supplies all other +24V dc requirements, including relays, solenoids, and solenoid drivers.

Two dc ground lines are used. The ground line for the +24V regulator, +6V, -4V, and -30V supplies (logic ground) is connected to the machine base. A separate ground line is used for the +24V driver supply. Both dc ground lines are connected to the using system as separate lines.

+18V DC and -18V DC Voltage Regulators

Two voltage regulators are used to generate +18V dc and -18V dc supplies. The +18V dc supply is generated from the '+24V dc' regulator line, and the -18V dc supply from the '-30V dc' line. The two 18-volt supplies are connected across the machine interface for use by the using system.

Both series voltage regulators are on a 2 x 2 SLT card mounted in Y logic gate. The series regulating power transistors are mounted on a heat sink on the logic gate.

The regulated supplies obtained are:
+18V dc ±3%, maximum current 600 mA
-18V dc ±3%, maximum current 300 mA

POWER SEQUENCING

Power On Sequence

The +6V dc, and -4V dc supplies must be switched on at least 5 ms before the +24V dc supply is applied.

Power Off Sequence

The +24V dc supply must have decayed to at least 2.5V dc before the +6V dc, and -4V dc supplies are switched off.

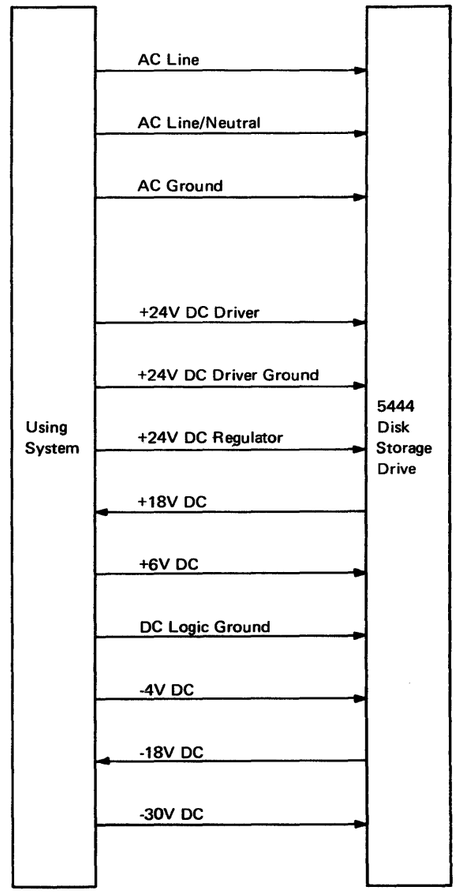


Figure 1-62. Input Power Lines [07523]

Section 1. Console

OPERATOR CONSOLE

There is no operator console.

CE CONTROL PANEL

- **Contains two switches for CE control; the 5444 is automatically read-selected and write-inhibited.**

The CE control panel (Figure 1-63) is mounted on top of the DC box (see Figure 1-4) and contains two switches for CE control of carriage movement and head selection. CE control is effected when the mode-select switch is set to any position other than ON-LINE; 'ready' line to the using system drops. Under CE control, the machine is automatically write-inhibited: any read/write head can be selected.

Note: Carriage travel is still restricted by the home detection logic and the carriage overrun interlock switch, as for normal on-line operation.

Mode-Select Switch

- **Using the mode select switch, the CE can select any read/write head.**

The mode-select switch is a seven-position rotary switch as follows:

On-Line Position

The 5444 is functionally connected to the using system; the CE controls are inoperative.

On-Track Position

The carriage moves one track for each operation of the forward/reverse switch.

Ten-Track Position

The carriage moves through a nominal 10 tracks for each operation of the forward/reverse switch. (The number of tracks moved is dependent upon the starting address; the address at which the carriage stops is dependent upon the direction of travel.)

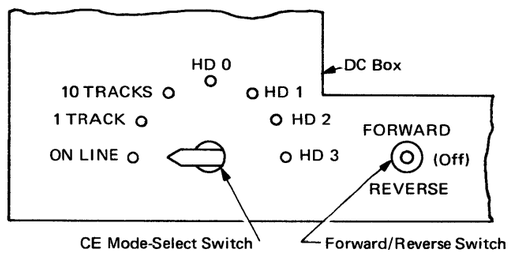


Figure 1-63. CE Control Panel [07524]

Forward Travel: Starting from track 000, the carriage moves to track 011, then to track 021, 031, and so on, for successive operations of the forward/reverse switch. When starting from an intermediate track, track 024 for instance, the carriage moves to track 031, 041, and so on.

Reverse Travel: Starting from track 202, the carriage moves to track 199, then to track 189, 179, and so on for successive operations of the forward/reverse switch. When starting from intermediate tracks, track 167 for instance, the carriage moves to track 159, 149, and so on.

Head 00 Position

Selects the upper head of the upper removable disk.

Head 01 Position

Selects the lower head of the upper removable disk.

Head 02 Position

Selects the upper head of the lower fixed disk.

Head 03 Position

Selects the lower head of the lower fixed disk.

Forward/Reverse Switch

- **The forward/reverse switch determines the direction of travel of the carriage when the 5444 is under CE control.**

The forward/reverse switch is a three-position toggle switch, biased towards a central off position. The switch is used with the '1 Track' and '10 Track' positions of the mode select switch, to determine the direction of carriage movement; in the forward position, the carriage moves towards the center of the disk; in the reverse position, the carriage moves away from the disk center.

Section 2. Maintenance Facilities

CE CYLINDER

- **One cylinder on each disk is reserved for fault finding.**
- **Customer access to the CE cylinder is inhibited.**

Cylinder 203 on Models 2 and 3, and cylinder 103 on Model 1 are reserved for fault diagnosis of the read/write circuits. The CE has, therefore, four *tracks* available on Models 1 and 2, and two *tracks* on Model 3.

Customer access to the CE cylinder is inhibited by the operating system program. (Customer access is limited to cylinders 000 to 202 on Models 2 and 3, and 000 to 102 on Model 1.)

CE DISK CARTRIDGE

- **Used during maintenance.**
- **Assists circumferential adjustment of the upper index transducer.**
- **Assists adjustment of the head/arm assemblies.**
- **Two pre-recorded cylinders (005 and 073) are used in these adjustment procedures.**

A CE disk cartridge contains two pre-recorded cylinders, 005 and 073, which are used during adjustment procedures to the head/arm assemblies and to the upper disk index transducer. Cylinders 004, 005, 006, and 071 through 075, should not be written on, otherwise the pre-recorded information will be destroyed. Any other cylinders may be used for test purposes.

The CE cartridge is identified by its black top cover and white bottom cover. (Customer cartridges have a blue top cover with the white bottom cover.)

Cylinder 005

Cylinder 005 is used for circumferential adjustment of the upper index transducer and has a single flux transition marker recorded 180° from the center-line of the index slot. To assist in identifying this marker it is followed after 10μs by a train of pulses.

Cylinder 073

Cylinder 073 is used for adjustment of the head/arm assemblies. Two concentric cylinders either side of cylinder 073 are spaced 0.010 in. (0,25 mm) apart. The cylinders are written with slightly different frequencies; head arm tracking adjustment is carried out by monitoring the beat frequency at cylinder 073.

TRACK POSITION INDICATION

- **A scale and pointer indicates the carriage position to the nearest ten tracks.**
- **Fine track position indication is obtained from numbered track crossing slots on the drive disk.**

Track position indicators indicate the location of the read/write heads over the recording area. Coarse indication (that is, within 10 tracks) is provided by a

scale on the top of the actuator frame (see Figure 1-17). Fine indication is provided on the drive disk; the numbered track crossing slots on the drive disk provide single track indication (Figure 1-64).

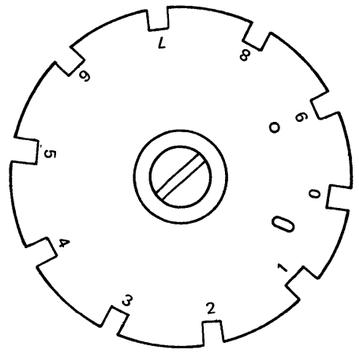


Figure 1-64. Drive Disk [07525]

MANUAL OPERATION AIDS

- **The disk drive mechanism and the carriage assembly may be moved manually when ac and dc power are removed.**

Drive Mechanism

With ac and dc power removed, the disk drive mechanism can be rotated manually using the drive belt pulleys.

Carriage Assembly

No special aids are provided for manual operation, but the carriage may be moved, with ac and dc power off, by pulling back the detent yoke and securing it with the holdout hook.

CAUTION
The face of the drive disk must not be touched.

Part 2. Maintenance

Section 1. Reference Data

1.1 FUNCTIONAL CHARACTERISTICS

The 5444 is available in the following models:
Model 1. Fixed disk and removable disk, using tracks 000 through 103 of each disk, and providing a storage capacity of 2.46 million bytes.
Model 2. Fixed disk and removable disk, using tracks 000 through 203 of each disk, and providing a storage capacity of 4.92 million bytes.
Model 3. Removable disk only, using tracks 000 through 203, and providing a storage capacity of 2.46 million bytes. Model 3 can only be installed as an addition to Model 2.

1.1.1 Format

Using a format of 256 data bytes in 24 sectors, the storage capacity is arranged in the following manner:

Each track:	6,144 bytes
Each cylinder:	12,288 bytes
Each disk:	2.46 million bytes.

The format is completely determined by the program of the using system. Figure 2–1 illustrates typical track and sector formats.

1.1.2 Speed

The speed of the 5444 is as follows:

Rotation time:	40 milliseconds, that is, 1,500 rpm
Data rate:	200 kilobytes per second
Single-track access:	39 milliseconds maximum.

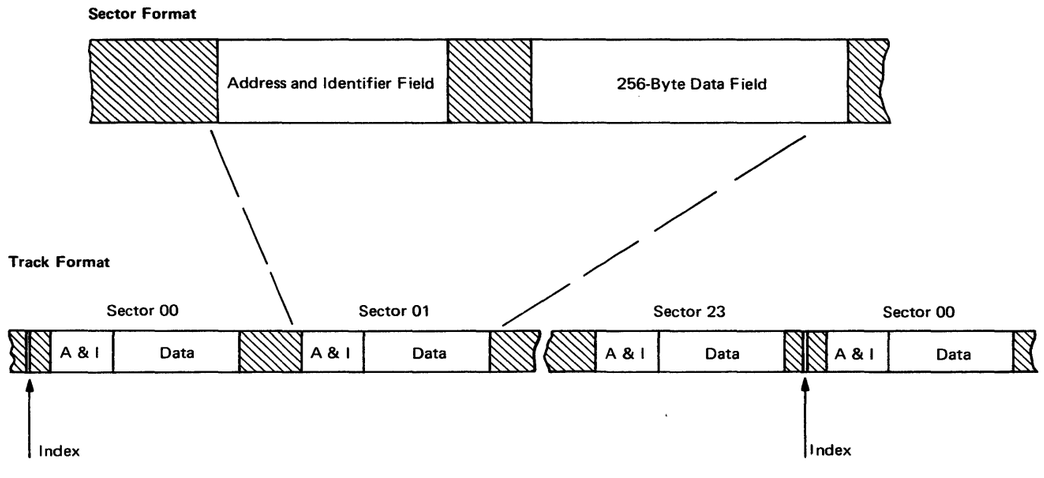
1.2 INTERFACE

Figure 2–2 shows the interface connections at the 5444. Logic circuits within the 5444 use SLD*/100 signal levels, and the lines at the interface are at these levels. The SLD/100 levels are as follows:

Positive (+):	+3.0V to +6.6V
Negative (-):	0V to +0.3V

Note: The 'rd data' line is at a special level of approximately 0V to -3V.

* Solid Logic (Dense)



A & I = Address and identifier field

5444 Model 1: 103 customer tracks (000 through 102) and CE track are used on one disk surface.

5444 Models 2 and 3: 203 customer tracks (000 through 202) and CE track are used on one disk surface.

Track 000 is used for initial program loading and for other system requirements.
Tracks 001, 002, and 003 are used as alternate tracks.
Track 103 or 203 (as appropriate) is used as the CE track.

Figure 2-1. Typical Sector and Track Formats [07526]

1.3 ALD PACKAGE

The page numbers of automated logic diagrams (ALD's) for the 5444 are prefixed FN and WK. Wiring diagrams and component location diagrams are prefixed ZA and ZZ. Page OA-000 supplies an index to the major ALD page groups.

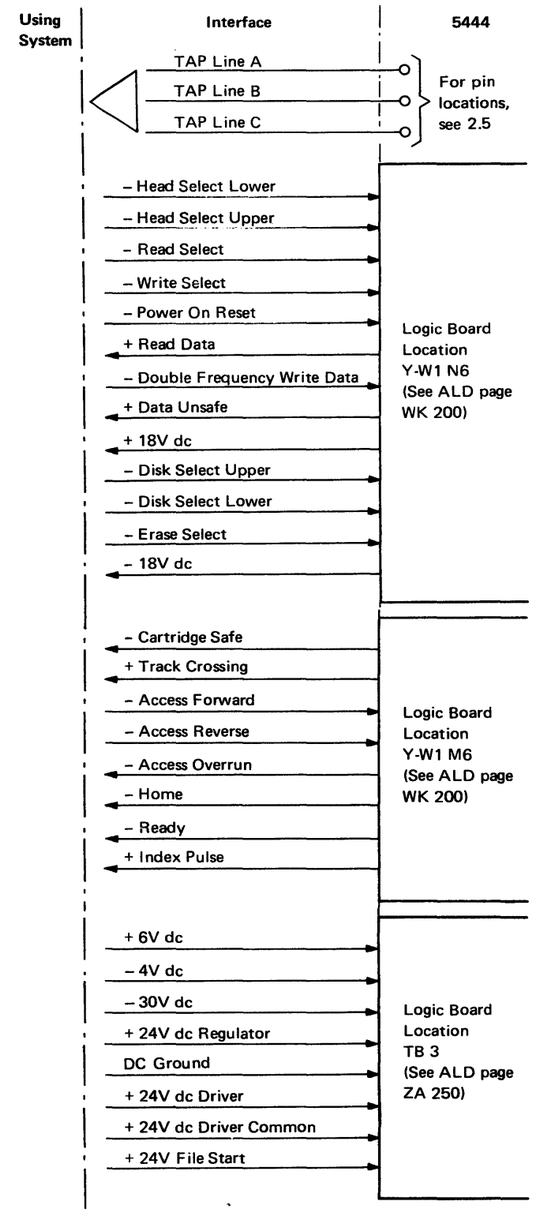


Figure 2-2. 5444-to-System Interface [07527]

Section 2. Diagnostic Techniques

CAUTION
Switch off power before removing or installing SLD cards. Use the correct probe tips when connecting the oscilloscope or meter to the logic pins.
The 5444 may be taken off-line by operation of the CE mode-select switch (see 2.2.1). AC and dc power remain on.

1.4 APPROACH TO SERVICING

Take the following approach to servicing the 5444:
1. Obtain the operator's report.
2. Use any error printout routine that the program of the using system provides.
3. Run any available diagnostic programs.
4. Use the appropriate maintenance analysis procedure (MAP) charts, which are contained in the documentation of the using system. See 2.4.4.

1.4.1 Major Functional Areas

1.4.1.1 Data Recording Area

Data-recording functions are provided by the following areas:
1. Read/write heads.
2. Read/write electronics (four cards).
3. Unsafe-condition latches (three latches).
4. Upper and lower index transducers and amplifiers.
5. Disk surfaces.

The 5444 can neither detect errors in the recording area nor recover from these errors, except to signal 'data unsafe' to the using system.

1.4.1.2 Access Area

Disk-accessing functions are provided by the following areas:
1. Electronic control of mechanical motion.
2. Drive mechanism.
3. Track-crossing detector.
4. Home detector.

To prevent damage to the drive tire, circuits protect the forward and reverse clutches from simultaneous energization.

Access errors occur when the actuator is directed to a track but fails to correctly position at this track. The 5444 can only either signal 'access overrun' or stop at track 000 and signal 'home'. If the carriage is driven past the home position, either the R/W heads unload at track minus 001 or the trip mechanically unloads the heads before the carriage is fully retracted.

1.4.1.3 Operational Control

Operational control is provided by the following areas:
1. Carriage interlock switches.
2. Head-load/unload controls.
3. Speed detectors.
4. Head-load interlock switches.
5. Cartridge interlocks.

Any errors in these areas de-activate the 'ready' line, or fail to supply index pulses. Any failure of the speed detector does not allow the 'cartridge safe' line to set.

1.4.2 Error Conditions

1.4.2.1 Unsafe Conditions

The unsafe condition is generated from the following latches (see ALD page FN230):
1. 'Write unsafe' latch.
2. 'Erase unsafe' latch.
3. 'Read/write select unsafe' latch.

Write Unsafe Latch: This is set by any one of the following conditions:
1. Write operation is selected but no write transitions are detected.
2. Write operation is selected and multiple R/W heads are selected.
3. Write operation is not selected but write current is on.

Erase Unsafe Latch: This is set by either one of the following conditions:
1. Write operation is selected but erase current is not on.
2. Write operation is not selected but erase current is on.

Select Unsafe Latch: This is set by any one of the following conditions:
1. Read and write operations are selected.
2. Read and erase operations are selected.
3. Carriage is not detented and either a write or erase operation is selected.

1.4.2.2 Not-Ready Conditions

The 'file ready' line indicates to the using system that the 5444 is ready. A not-ready state may be caused by one of the following faults:
1. One of the interlock switches has failed.
2. The rotational speed is less than 64% of full speed.
3. An incorrect head-loading sequence has occurred.
4. AC or dc power has failed.
5. An unsafe condition has arisen.
6. The CE mode-select switch is not set to ON LINE.

1.4.2.3 Access Overrun Condition

The access-overrun error condition is signaled by 'access overrun' to the using system. The signal is raised when the carriage overrun interlock switch senses that the carriage is too close to the center of the disk. The sensing occurs at track 204/205½ (5444 Models 2 and 3) or track 104/105½ (Model 1 only), and de-energizes the forward clutch to prevent the carriage from driving further forward.

1.4.2.4 Read/Write Errors

Read/write errors can be detected only by the using system. The 5444 has no means of parity checking.

1.5 ERROR RECOVERY PROCEDURES

Figures 2–3 and 2–4 provide error recovery procedures for use when a suspected head-to-disk interference (HDI) has occurred or when R/W heads 02 and 03 are aligned. See 4.7.1.3 for head alignment details.

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See overleaf for Figure 2-3.

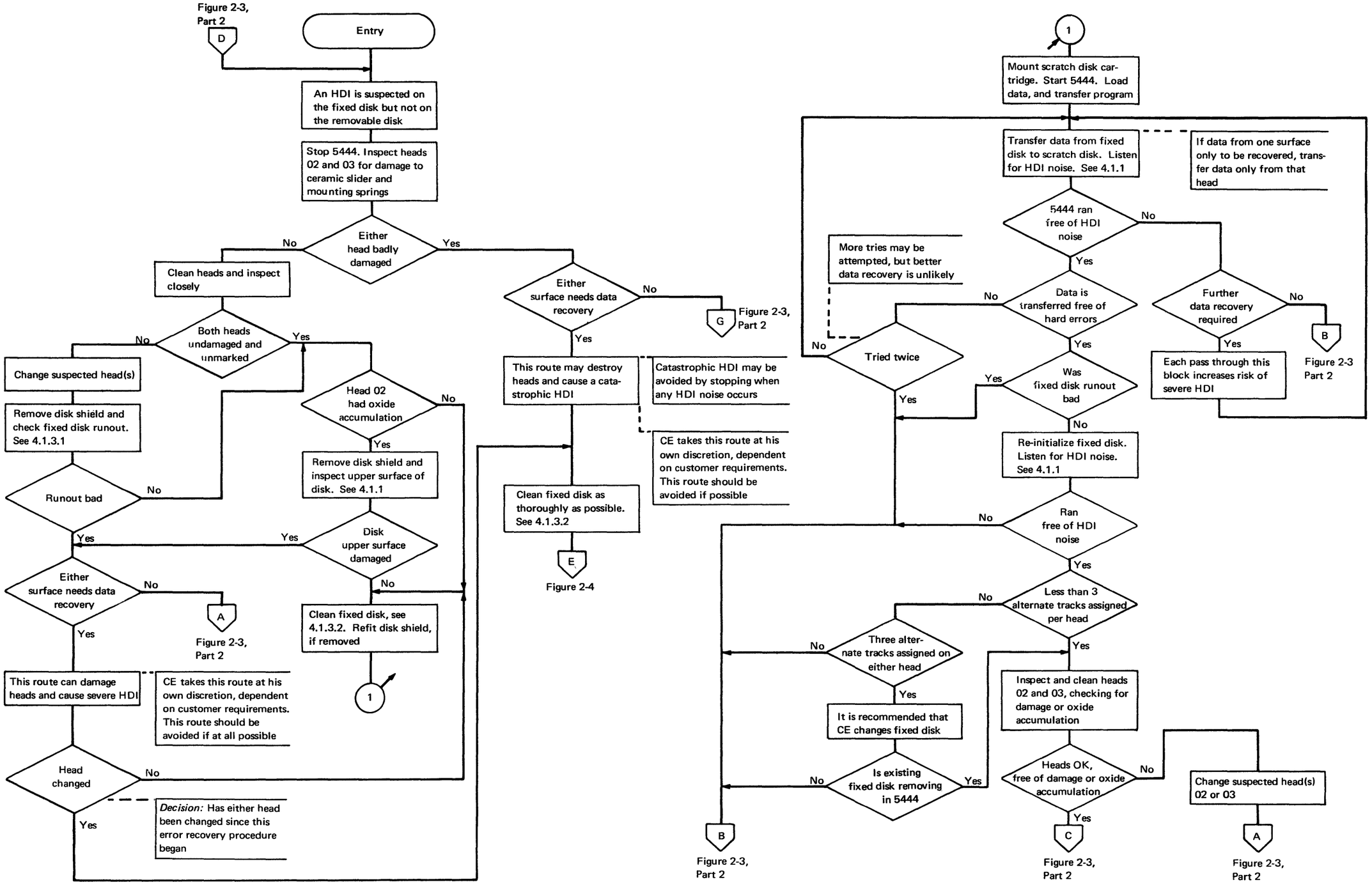


Figure 2-3. Error Recovery Procedure – Suspected HDI on Fixed Disk (Part 1 of 2) [07528]

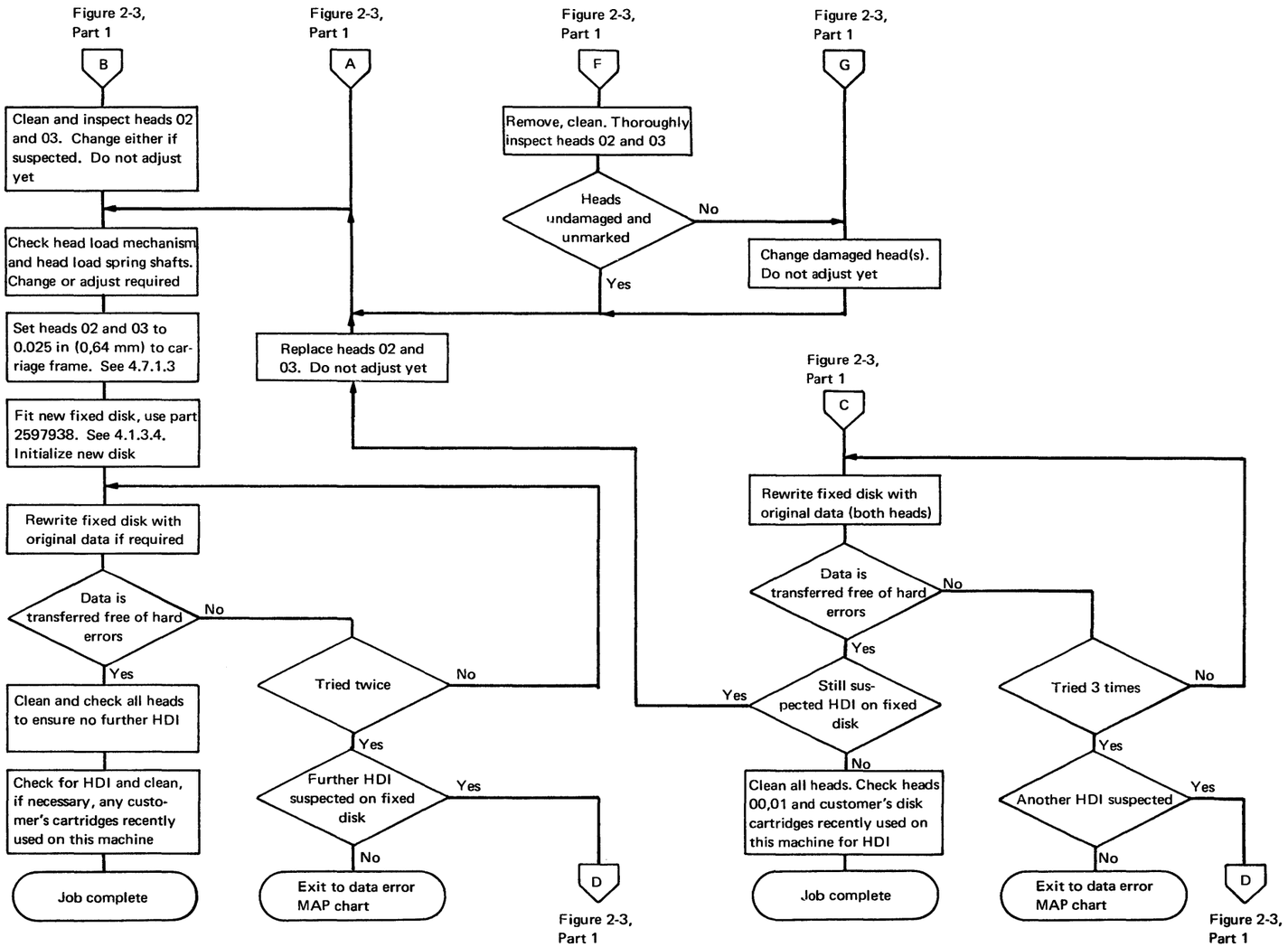


Figure 2-3. Error Recovery Procedure – Suspected HDI on Fixed Disk (Part 2 of 2) [07529]

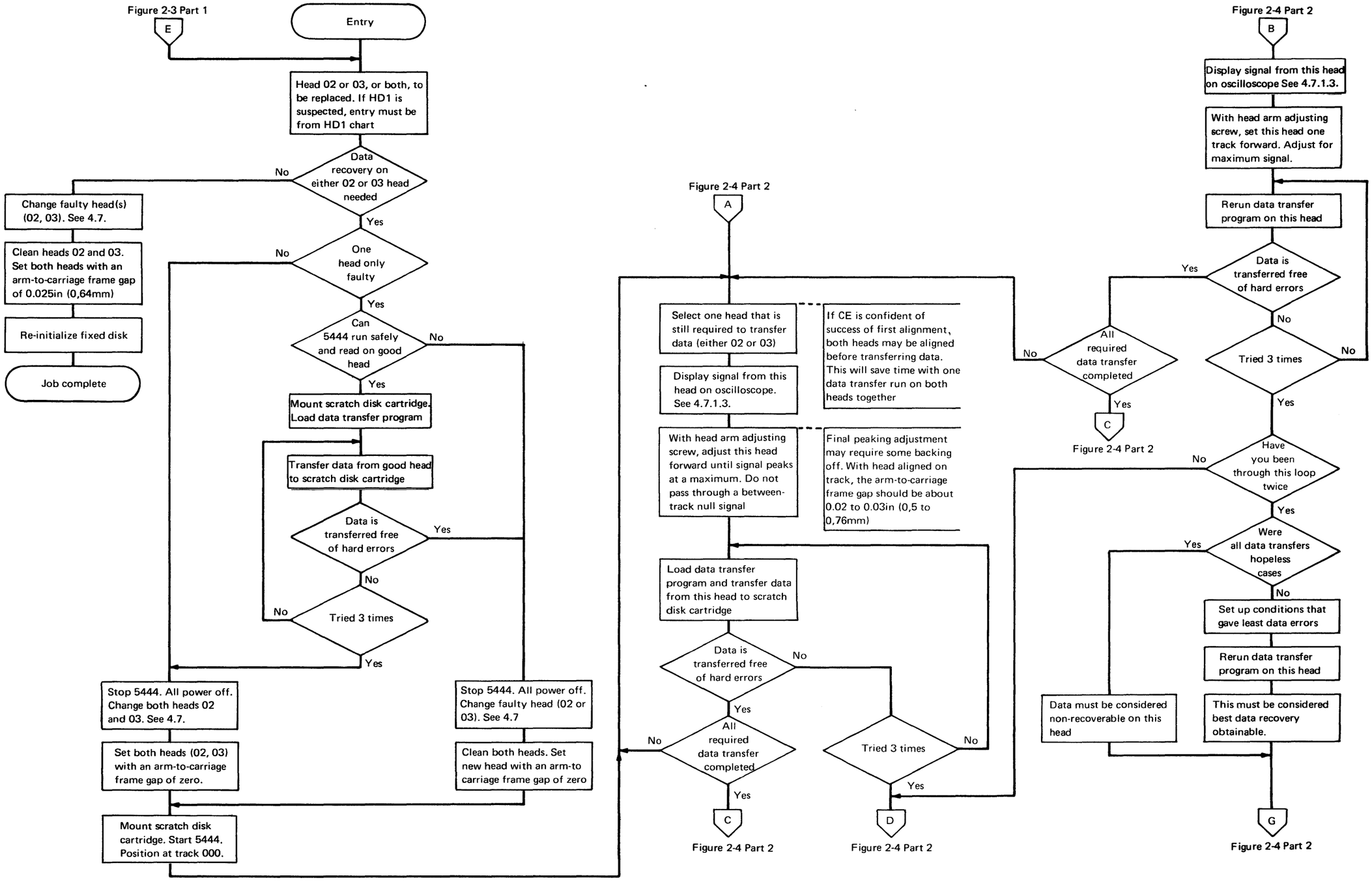


Figure 2-4. Error Recovery Procedure – R/W Head 2 or 3 Replacement (Part 1 of 2) [07501]

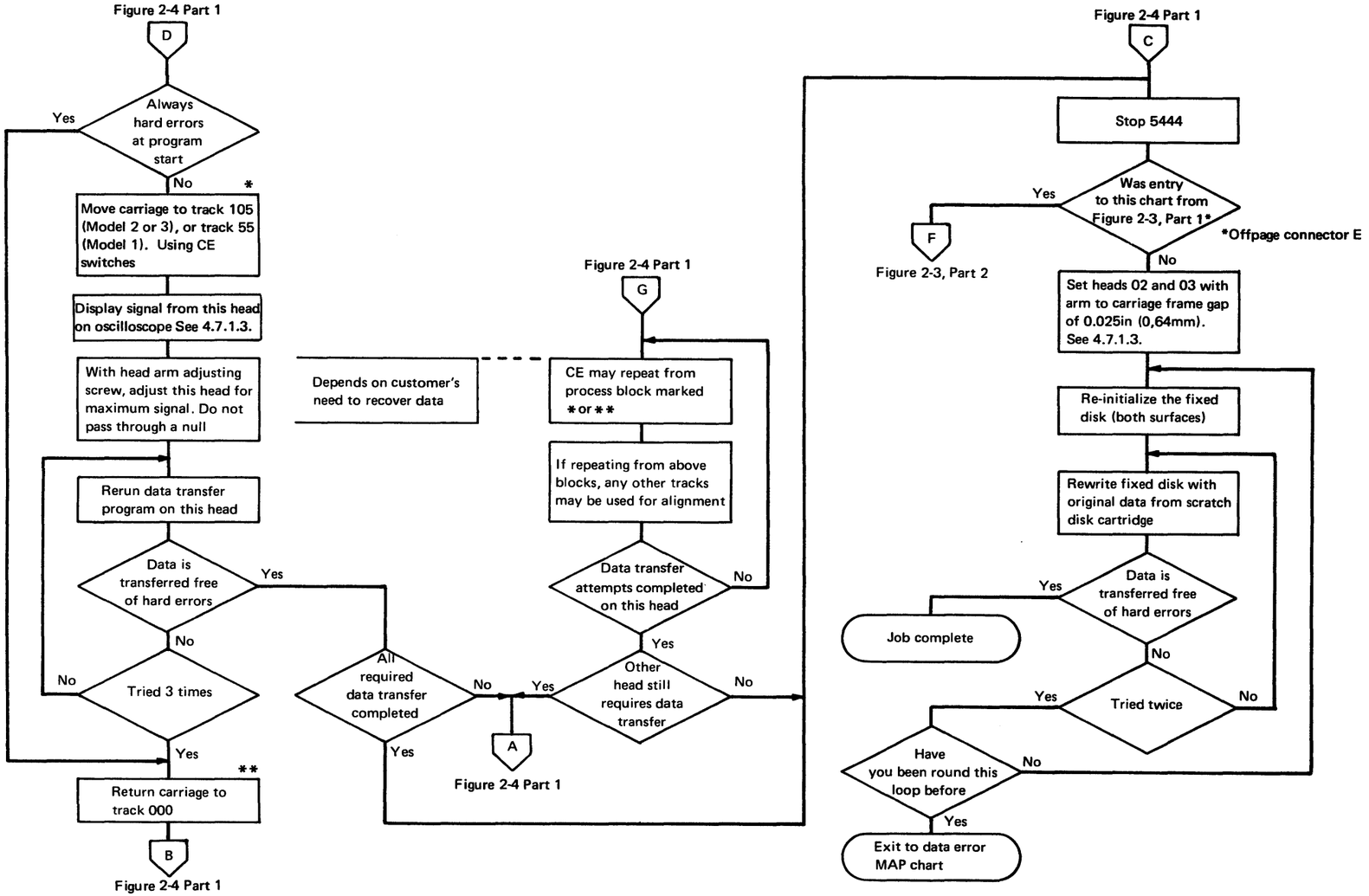


Figure 2-4. Error Recovery Procedure – R/W Head 2 or 3 Replacement (Part 2 of 2) [07530]

Section 1. Basic Unit

2.1 CONSOLE

The 5444 is not provided with an operator console. Refer to the using system manuals for the method of controlling the machine.

2.2 CE PANEL

The CE panel (Figure 2–5) is mounted on the dc box at the rear of the machine and is provided with two switches: a CE mode-select switch and a forward/reverse switch. When the 5444 is under control of these switches, the 'home' latch and the carriage overrun interlock switch limit the carriage travel to the recording area between tracks 000 and 203 (Models 2 and 3) or track 103 (Model 1).

2.2.1 CE Mode-Select Switch

On the CE mode-select rotary switch, one on-line position and six off-line positions can be chosen. When the switch is set to ON LINE, the 5444 is controlled by the using system. When the switch is set to an off-line position, the 'file ready' signal is disabled, the write circuits are blocked, and the 5444 is selected for read operation. Individual off-line settings are as follows:

1 Track: Allows the carriage to move across one track for each operation of the forward/reverse switch.

10 Track: Allows the carriage to move across ten tracks for each operation of the forward/reverse switch. The carriage overshoots by one track, that is, to track 11, 21, 31 (and so on) in the forward direction, and to track 29, 19, 9 (and so on) in the reverse direction; the first forward/reverse operation moves the carriage to the next overshot position, not necessarily the full ten tracks.

HD 0: Upper head, upper disk
HD 1: Lower head, upper disk
HD 2: Upper head, lower disk
HD 3: Lower head, lower disk
} All heads are read selected

Head pre-amplifier output may be monitored at logic board pins Y-W1 K6J10 or Y-W1 K6J12.

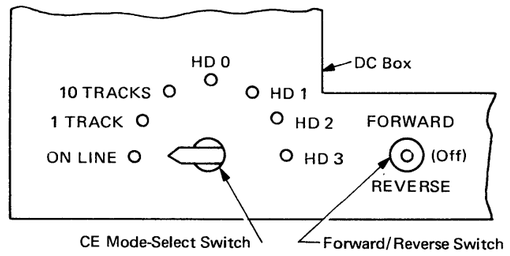


Figure 2-5. CE Panel on DC Box [07524]

2.2.2 Forward/Reverse Switch

The forward/reverse toggle switch is center biased, the center position being 'off'. The switch provides directional control for the carriage when the CE mode-select switch is set to either 1 TRACK or 10 TRACK (see 2.2.1).

2.3 CE TOOLS AND THEIR USE

Special tools for servicing the 5444 are located at either the branch office or the customer installation.

2.3.1 Branch Office/Support Center Tools

The following tools are provided at the branch office or support center:

Tool	*IBM Part*
Actuator Alignment Tool	5831644
Cartridge Support Clip (4 supplied)	2537562
Clutch Setting Gage	2597940
Disk-Clearance and Head-Load Spring Gage	5831639
Head-Clearance Gage	5831638
Head-Load Gage	2536600
Hub Tool	2537550
Nylon Gloves	461621
Runout Gage	2536591
T-Handle Wrench, 3/16" hexagon	460947
Tire Wear Gage	2597962
Torque Screwdriver, 10 lb in. (11,5 kg cm)	2597968
Torque Wrench, 8 lb in. (9,2 kg cm)	2598187

The following items are required (from using system inventory) for servicing the 5444:

Tool	*IBM Part*
CE Probe (see 2.3.3.1)	817971
Oscilloscope, Tektronix* 453	453047

2.3.2. Customer Installation Tools

Tool	*IBM Part*
Actuator Pin Gage	2597946
Screwdriver Adapter	2597970
6-Flute Adapter, Size 4-40	2597971
CE Cartridge (see 2.3.3.2)	2537301
Disk and Head Cleaning Paddle	2108474
Feeler Gages:	
0.003 in.	2536581
0.004 in.	2536582
0.005 in.	2536583
0.007 in.	2598179
0.010 in.	2598040
0.014 in.	2598041
0.016 in.	2598042
Head Cleaning Brush	2200106
Isopropyl Alcohol, 6oz	2200200
Lint-Free Tissues	2162567
Torque Wrench, 4 lb in. (4,6 kg cm)	2597969

2.3.3 Tools Use

2.3.3.1 CE Probe

The MAP charts (see 2.4.4) call for use of the CE probe, part 817971. Details for using the tool are given in the manuals of the using system.

2.3.3.2 CE Cartridge

The CE cartridge, part 2537301, is similar to the 5440 Disk Cartridge but is identified by a black top. The disk contains pre-written tracks at cylinders 005 and 073 (that is, the tracks 005 and 073 on both surfaces of the cartridge disk) that are used during the adjustment of the upper index transducer and the read/write head arm assemblies.

*Trademark of Tektronix, Incorporated

CAUTION
Do not, under any circumstances, write on the tracks at cylinders 004, 005, 006, 071, 072, 073, 074, or 075 of the CE cartridge. Overwriting on these tracks destroys the alignment data. Always check the track number before starting writing operations.

Pre-Written Tracks 005 (Upper Index Transducer Adjustment): A recorded marker pulse, followed after ten microseconds by a train of pulses, is provided on tracks 005. The upper index transducer is adjusted, as described in 4.2.3, until the marker pulse appears 30 microseconds after the index pulse.

Pre-Written Tracks 073 (Head Arm Alignment): Cylinder 073 of the CE cartridge has two circular concentric tracks that are spaced 0.010 in. (0,25 mm) apart and are 0.0015 in. (0,04 mm) eccentric to the disk; these tracks are written at slightly different frequencies. A head that is correctly centered over track 073 gives an oscilloscope trace with an equal two-lobed pattern. The pattern and adjustment procedure are described in 4.7.1.3.

2.4 MAINTENANCE AIDS

2.4.1 Fixed Disk CE Track

On the fixed disk of the 5444, the tracks at cylinder 203 (5444 Models 2 and 3) or cylinder 103 (Model 1) are reserved for CE use. These tracks may be written on without customer data being disturbed.

2.4.2 Track Position Indication

To indicate the approximate position of the R/W heads, a scale and pointer are provided. The scale (on the top of the actuator frame) is marked in ten-track intervals, and the pointer (on the carriage) moves along the scale; a mark at the left-hand end of the scale shows the fully retracted position of the carriage. The indication may be viewed through a window in the top cover of the 5444.

To indicate the head position within the ten-track graduations on the scale, the flexible drive disk of the detent assembly is provided with slots, numbered 0 through 9. The number of the slot that is between the track-crossing lamp and the track-crossing photocell is

also the number of the track within the particular graduations. This indication can be viewed through the transparent detent cover at the rear of the 5444.

2.4.3 Detent Yoke Holdout

It is frequently necessary for the CE to manually move the carriage, with the detent pawls held out of engagement. To disengage the pawls, carefully move the yoke (Figure 2–6) towards the voice coil, loosen the hook securing screw, and engage the hook on the projection.

After servicing, make sure that the hook is secured by its screw clear of the yoke.

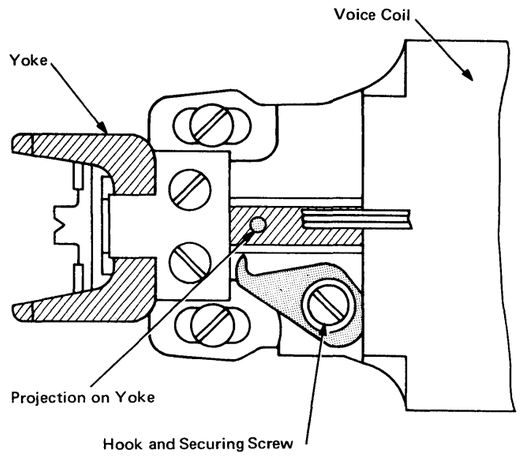


Figure 2-6. Yoke Holdout Hook [07531]

2.4.4 MAP Charts

Maintenance analysis procedure charts are the primary tools for fault diagnosis. Presented as flowcharts, they guide the CE to the area of a failing component. The MAP charts are contained in the documentation of the using system, together with a description of their use.

2.4.5 TAP Lines

Jumpers are connected to the pins of the logic board in the 5444, from the timing analysis program (TAP) lines, as follows:

	TAP's Line Driver Pin		*Unsafe Latch Pin*
TAP Line A	Y-W1 G7 B03	to	Y-W1 H6 B10
TAP Line B	Y-W1 G7 B05	to	Y-W1 H6 G04
TAP Line C	Y-W1 G7 B04	to	Y-W1 H6 G03

Note: If the jumpers that are normally installed between the unsafe latches and the TAP line driver input pins are changed during the running of diagnostic programs, these jumpers must be returned to the proper pins or, otherwise, customer programming errors may occur.

Section 2. Features

No features are fitted to the 5444.

Section 1. Basic Unit

3.1 APPROACH TO PREVENTIVE MAINTENANCE

Preventive maintenance allows the customer to use his 5444 for the maximum possible amount of time. Maintenance that does not reduce downtime is unnecessary.

3.1.1 Visual Inspection

When the opportunity occurs to visually inspect the 5444, look for corrosion, dirt, wear, cracks, binding, and loose connections. Take remedial action so that more serious faults may be avoided.

3.1.2 Electronic Units

The program of the using system incorporates diagnostic programs which, if regularly used, will assist in tracing intermittent and potential sources of trouble.

3.1.3 Mechanical Units

The main steps in preventive maintenance of mechanical units are: clean, inspect, and lubricate. Do not adjust or dismantle a correctly functioning unit, even if the tolerances vary from those given in "Checks, Adjustments, and Removals".

3.1.4 Cleanliness

The 5444 is sensitive to dust particles. Always maintain strict cleanliness, therefore, whenever maintenance work is carried out. If the top cover is removed from the machine, install the CE cartridge, part 2537301, before carrying out any work. Do not let lubricants accumulate inside the machine.

Unit	Frequency (Months)	Cleaning	Inspection	Lubrication
Air Filter	During any servicing	None	Check that filter is not dirty and damaged. See 4.2.5.1	–
Drive Disk	3	Clean with isopropyl alcohol	Check that disk is not bent. See 4.5.3.1	–
Drive Tire	3	Clean with isopropyl alcohol	Check that tire is not worn. See 4.5.2.1	–
Read/Write Heads	3 (See Note 1)	See 3.2.2.2 and 3.2.2.3	Check for freedom from particle damage and oxide deposits. See 3.2.2.1	–
Carriage Slides	6 (See Note 2)	Clean with isopropyl alcohol	–	Lubricate with IBM no. 20 grease. See 3.2.1.1
Disk Cleaning Brushes	6	–	Check that brushes are not worn; see 4.3.1.1. If worn, change; see 4.3.1.2	–
Leadscrew	6 (See Note 2)	Clean with isopropyl alcohol	–	Lubricate with Molykote 'G'.* See 3.2.1.1
Detent Wheel, Yoke Guide	6 (See Note 2)	–	–	Lubricate with IBM no. 9 oil. See 3.2.1.2
Drive Belt	12	–	Check that belt is not frayed and cracked. Change if necessary, see 4.2.7	–
Drive Motor	12	–	–	Lubricate with IBM no. 6 oil. See 3.2.1.4
Pawl Bracket Assembly	12	–	–	Lubricate with IBM no. 9 oil. See 3.2.1.2

Notes:
1. This preventive maintenance depends on usage. If the usage exceeds 176 power-on hours per month, perform the maintenance every 528 power-on hours.
2. This preventive maintenance depends on usage. If the usage exceeds 176 power-on hours per month, perform the maintenace every 1,056 power-on hours.

* Trademark of Dow Corning Corporation

Figure 2-7. PM Routine Chart [07532]

3.1.4.1 Disks and Heads

When the read/write heads are flying above the disk surface, the clearance is about 85 millionths of an inch; very small particles, not visible to the eye, can cause dirt to accumulate on the head faces, and this accumulation can damage the disk and/or heads.

3.1.4.2 Actuator Assembly

The actuator area is susceptible to dirt and damage. Deep any removed parts in a dust-proof plastic bag.

Keep the drive tire and drive disk clean and free from contamination by oil or dirt.

3.1.4.3 Voice Coil Assembly

The magnet of the voice coil assembly may attract magnetic debris, which can cause failure of the unit. The debris can be removed by picking off with adhesive tape. When the voice coil is removed from the machine, do not place it on a dirty surface.

3.2 PM PROCEDURES

CAUTION
Do not allow tools or parts to fall into the machine when the top cover is removed. In particular, avoid damage to the disk.

Carry out the preventive maintenance that is given in Figure 2-7. The locations are shown in Figure 2-8.

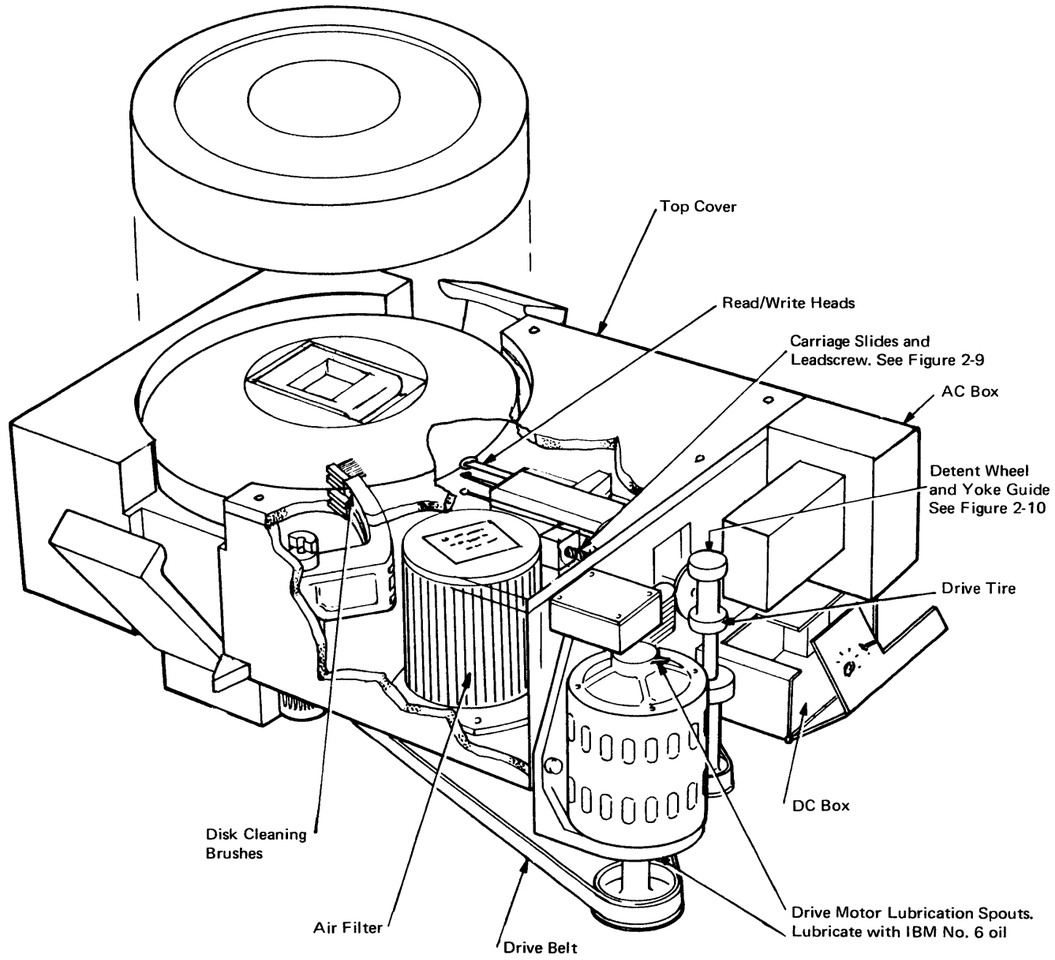


Figure 2-8. PM Locations [07533]

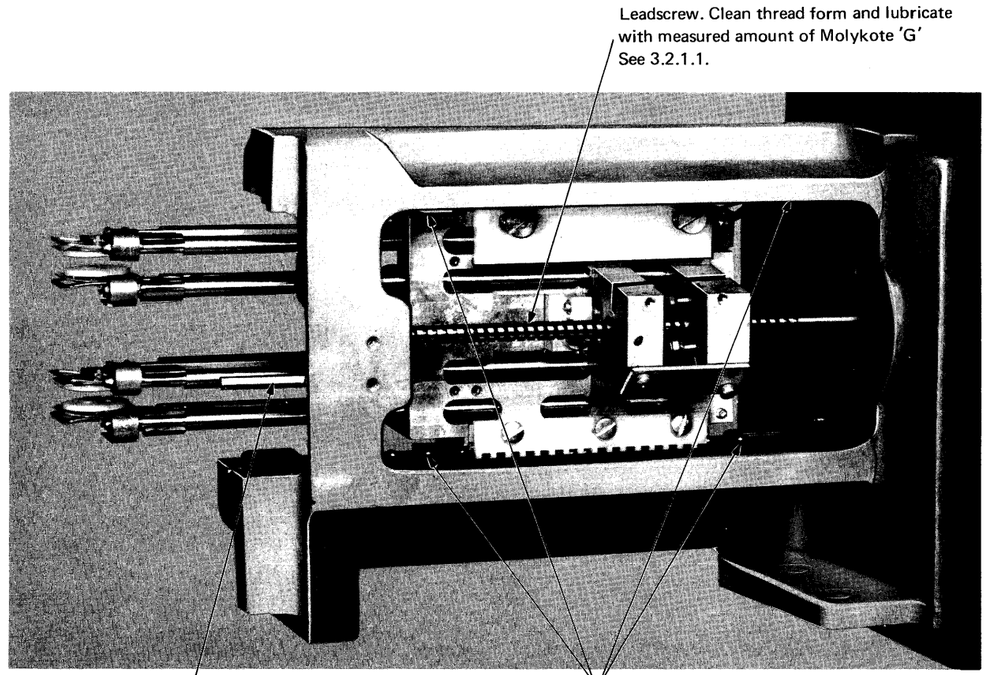


Figure 2-9. Carriage Slides and Leadscrew Lubrication [07535]

3.2.1 Lubrication Details

3.2.1.1 Leadscrew and Carriage Slide

1. Remove the following:
   a. Top cover.
   b. Air filter block the air duct with a lint-free tissue.
   c. Shield between air filter and carriage.
2. Manually move carriage to inner limit stop, after hooking back the voice coil yoke (see 2.4.3).
3. Clean the carriage slides and leadscrew (Figure 2-9) with lint-free tissues and isopropyl alcohol (see 2.3.2 for part numbers) to remove all traces of lubricant.
   Note: Do not move the carriage after lubricant has been removed.

CAUTION
In the following step, do not apply lubricant with the fingers because of the risk of contaminating other parts of the clean area.

4. Lubricate exposed thread of leadscrew with Molykote 'G'*, part 357830, by squeezing 1/8 to 1/4 in. of lubricant from a 0.150 in. nozzle on tube, part 357830 (0,035 to 0,070 cc). Lubricate carriage slides with IBM no. 20 grease; use minimum amount.
5. Move carriage back and forth to distribute lubricant. Wipe off excess with a lint-free tissue.
6. Remove tissue from air duct and refit air filter. Refit shield and top cover.

---

* Trademark of Dow Corning Corporation

3.2.1.2 Detent Wheel, Yoke, Springs, and Pawl Pivots

1. Remove detent end cover.
2. Lubricate the points shown in Figure 2-10 with IBM no. 9 oil. Use a small screwdriver to drip small amounts of oil on to the locations.
3. Clean drive tire and drive disk with isopropyl alcohol, part 2200200.

3.2.1.3 Drive Motor

1. Turn both lubrication spouts so that hollow openings face upwards.
2. Clean spouts, then drip in IBM no. 6 oil.
3. After lubrication is completed, turn spouts over, so that the hollows face downwards, to prevent dirt accumulating in them.

3.2.2 Read/Write Heads

3.2.2.1 Condition of Heads

Figure 2-11 shows the various conditions that may be found in the face of a read/write head.

Grooves: A large particle that is embedded in the disk surface may cut a groove or deep scratch in the head face, thereby attracting oxide deposits. If the face has grooves 0.010 in. (0,25 mm) apart, change the R/W head arm assembly (see 4.7.1).

Light Scratches: Clean the head (see 3.3.2.2).

Heavy Accumulation of Oxide: If a head has a heavy accumulation of oxide between the bleed holes and the pole tip, see 3.3.2.3.

Slight Accumulation of Oxide: Clean the head (see 3.3.2.2).

Alcohol Dried in Pools, Fingerprints, or Oily Deposits: Clean the head (see 3.3.2.2).

3.2.2.2 Cleaning R/W Heads (Light Oxide Deposits)

1. Remove top cover. Check that carriage is fully retracted.
2. Wrap a lint-free tissue around a disk and head cleaning paddle, and dampen with isopropyl alcohol (see 2.3.2 for part numbers). Carefully insert paddle between the two R/W head faces, and insert a tissue between the heads that are not being cleaned.

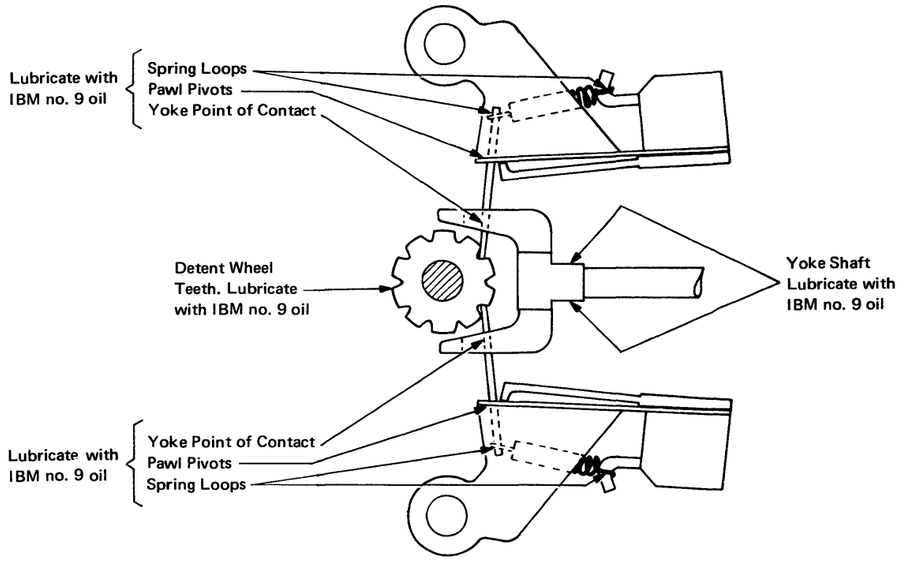


Figure 2-10. Detent Assembly Lubrication [07534]

CAUTION
Perform the following operation carefully. Do not touch the faces of the R/W heads with the fingers. Avoid leaving alcohol residue on the faces.

3. Close the heads by gently depressing head-load solenoid, then drawing paddle and tissue through the heads.
4. Repeat steps 2 and 3 until all oxide deposits are removed.
5. Dry the head with a dry tissue, in a similar manner to that for cleaning. Inspect with a dental mirror. If deposits of oxide still remain, see 3.2.2.3.
6. Repeat steps 2 through 5 for the other pair of heads.
7. Refit top cover.

3.2.2.3 Cleaning R/W Heads (Heavy Oxide Deposits)

If cleaning as described in 3.2.2.2 is unsuccessful, continue as follows:

1. Wet the head cleaning brush, part 2200106, with isopropyl alcohol and shake off any excessive liquid.

CAUTION
In the following steps, avoid touching the face of the R/W head with the fingers. Do not leave pools of isopropyl alcohol on pieces of tissue on the head face. Never blow on R/W heads and do not use excessive force when supporting them. Discard worn head cleaning brushes.

2. Supporting back of head with disk and head cleaning paddle, scrub face of head with brush, using a rotary motion. Give special attention to bleed holes and to leading and trailing edges of face.
   Note: Do not hit the head with the metal stem of the brush.
3. Wrap a lint-free tissue around a paddle, dampen tissue with isopropyl alcohol, and polish face of head.
4. Dry the head face with a dry tissue wrapped around a paddle.
5. Inspect surface of face, using a dental mirror, to make sure that all dirt and oxide deposits have been removed. If contamination still persists, change the head arm assembly (see 4.7.1.4 and 4.7.1.5).

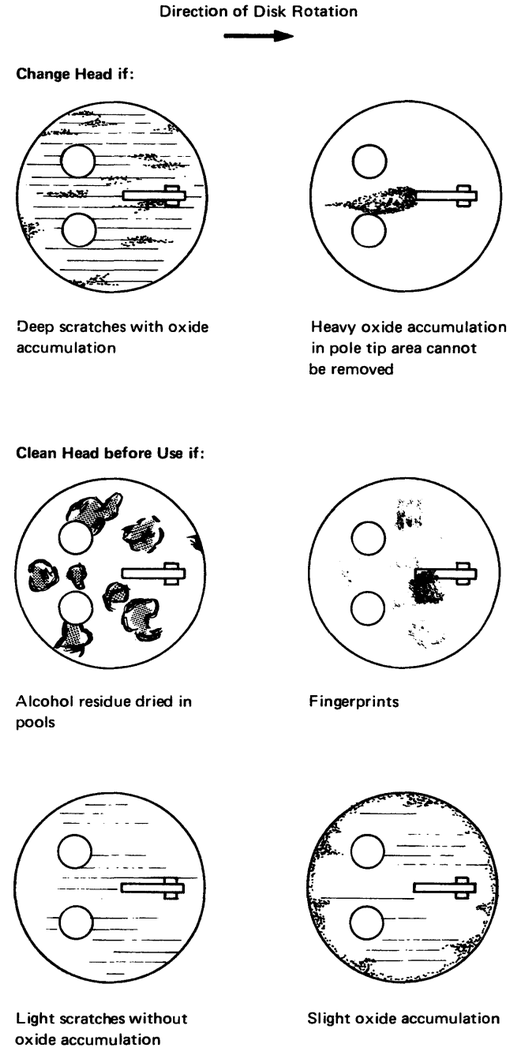


Figure 2-11. Conditions of Read/Write Heads [07536]

Section 1. Basic Unit

4.1 DISKS

CAUTION
If the 5444 produces tinkling or screeching noises, immediately inspect the disks *and* the read/write heads (see 4.7). *Always* change the disk and *never* transfer it to another machine.

4.1.1 Inspection – General

The condition of the faces of the read/write heads (see 3.2.2) is a guide to the state of the disk surfaces. A clean head that rapidly accumulates oxide deposits indicates that the disk surface is dirty or scratched, or has embedded particles. If cleaning or changing the heads (see 3.2.2.2 and 3.2.2.3) and cleaning the disks (see 4.1.2 and 4.1.3) do not rectify the condition, carefully examine the disk surfaces for scratches, embedded particles, and discolored spots on the oxide.

Error recovery and data dumping procedures are dealt with in the manuals of the using system. Basic error recovery procedures are given previously in 1.5.

4.1.2 Removable Disk (5440 Disk Cartridge)

CAUTION
1. Always check that the carriage and brush arm are completely retracted before taking off the disk cartridge.
2. Under no circumstances dismantle the disk cartridge.

4.1.2.1 Inspection and Cleaning

No maintenance schedule is given for disk cartridges. Whenever read/write head surfaces show an accumulation of oxide or dirt, clean the disk cartridge as follows:

1. Turn off power and remove top cover.
2. Open cartridge clamp arms and lift off disk cartridge.
3. Place hub tool, part 2537550, on spindle.
4. Fit four cartridge support clips, part 2537562, in the four slots around rim of cartridge (Figure 2-12).
5. Remove one cartridge clamp arm by removing the three attaching screws. If a runout check is to be made later (see 4.1.2.2), remove left-hand clamp arm.
6. Place cartridge on spindle of hub tool, aligning the cleaning brush entry port in cartridge with gap provided by removal of clamp arm.
7. Open logic gate (see Figure 2-46) to gain access to disk spindle pulley.
8. Wrap a lint-free tissue around a disk and head cleaning paddle and dampen with isopropyl alcohol. *Note:* For part numbers of tissue, paddle, and alcohol, see 2.3.2.
9. Insert paddle and tissue through cleaning brush entry port in cartridge. Manually rotate disk by spindle pulley, and, at same time, press tissue on disk surface being cleaned.
10. Withdraw paddle while the disk is still rotating.
11. Using another paddle with a dry tissue, dry the disk surface in a similar manner to steps 9 and 10. Ensure that no alcohol is left on surface.
12. Examine disk surface. If particles have been embedded such that they have not been removed by the cleaning, take the disk cartridge out of service.
13. Remove disk cartridge and hub tool.
14. Re-install cartridge clamp arm.
15. Remove clips from disk cartridge.
16. Re-install disk cartridge in machine and close clamp arms.
17. Refit top cover to machine.

If the hub tool and cartridge support clips are not available, clean as follows:

1. Turn off power.
2. Remove top cover and air filter; block the air duct with a lint-free tissue.
3. Remove cleaning brush arm. See 4.3.1.2.
4. Carry out steps 8 through 12 of foregoing cleaning procedure.

   Notes:
   a. This shortened method is more likely to cause disk damage than by mounting on a hub tool.
   b. The cleaning brush entry port is to the left of the actuator.
5. Remove tissue from air duct and re-install air filter. Refit top cover to machine.

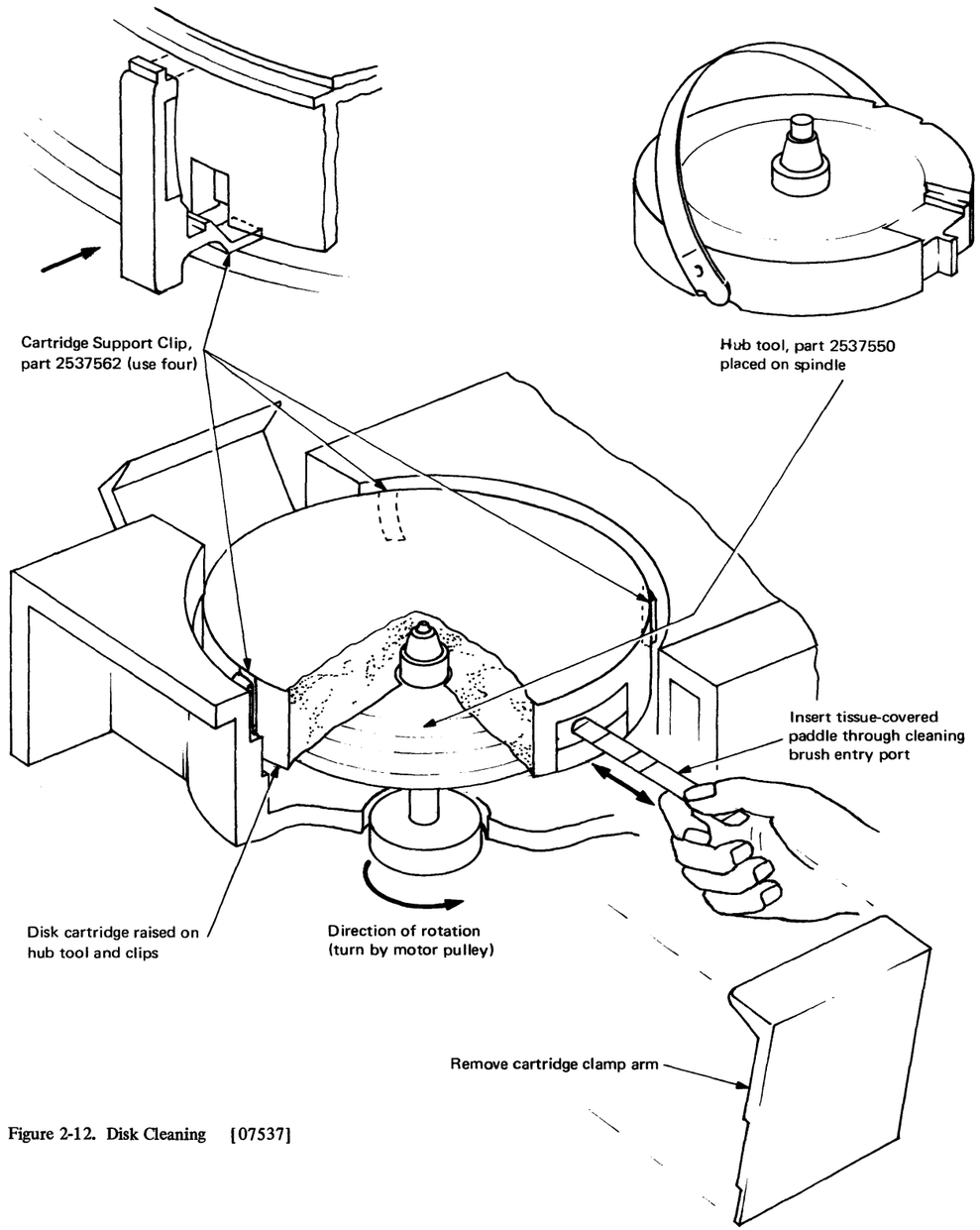


Figure 2-12. Disk Cleaning [07537]

4.1.2.2 Disk Runout Check

The term *runout* means edge wobble, or up-and-down movement, while the disk is rotating. To check runout:

1. Turn off power and remove top cover.
2. Open cartridge clamp arms and remove disk cartridge.
3. Place hub tool, part 2537550, on disk spindle.
4. Insert disk runout gage, part 2536591, under top rim of disk cartridge (Figure 2-13) so that gage arm rides on lower surface of disk. Fit cartridge support clips, part 2537562, in the four slots around rim of cartridge (see Figure 2-12).
5. Remove left-hand cartridge clamp arm by removing the three attaching screws.
6. Mount disk cartridge on spindle of hub tool, aligning the cleaning brush entry port with gap provided by removed left-hand clamp arm.
7. Slowly rotate disk by turning spindle pulley. If pointer on gage moves more than two divisions of the scale, runout is excessive and disk cartridge must be taken out of service.
8. Remove disk cartridge and all tools.
9. Re-install cartridge clamp arm.
10. Remove clips from disk cartridge. If cartridge is serviceable (see step 7), re-install it in machine and close clamp arms.
11. Refit top cover.

4.1.2.3 Cartridge Cover Cleaning

Clean dirt and stains from the cartridge cover with lint-free tissue that has been dampened with isopropyl alcohol. See 2.3.2 for part numbers of tissue and alcohol.

4.1.3 Fixed Disk

4.1.3.1 Inspection and Check

An indication of damage to the fixed disk may be gained from the condition of the lower R/W heads, persistent read or write errors, or noises from the machine. If head-to-disk interference has occurred, change the heads and the disk. Refer to the error recovery procedure for HDI, on Figure 2-3. Inspect disk cartridges that have been used prior to an HDI incident to make sure that they have not been dropping particles.

Visually inspect the upper surface of the fixed disk, after first removing the fixed disk shield. Examine the disk surface for:

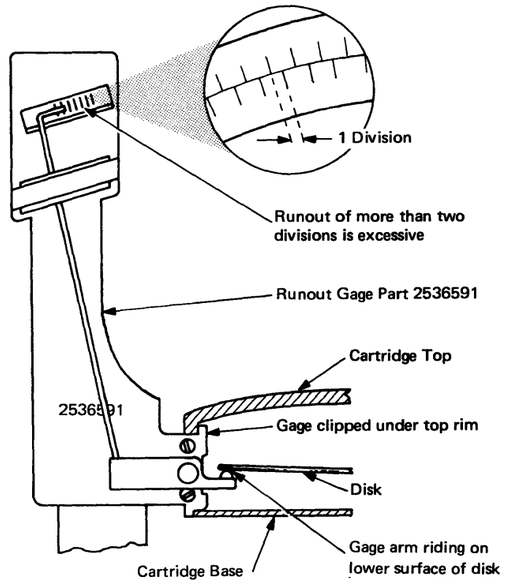


Figure 2-13. Runout Check – Removable Disk [07538]

1. Spiral scratches.
2. Scratches that expose metal.
3. Embedded particles.

If the lower surface is suspected, remove the disk to inspect it.

Carry out the disk height and runout check as directed by the error recovery procedure flowchart, or when fitting a new fixed disk, as follows:

1. Remove top cover and disk cartridge.
2. Remove fixed disk shield, pillar for head cable clamp, and head connectors from Z gate.
3. Mount disk-clearance and head-load spring gage, part 5831639, on machined pad (Figure 2-14) near the head entry port, with gage fingers turned towards the layshaft. Secure tool with captive screw in hole vacated by head cable clamp pillar.
4. Swing fingers 02 and 03 of gage towards head entry port so they overlap edge of disk.
5. Manually rotate disk (by the spindle pulley) through one revolution and observe if disk touches either finger.
   Note: If the disk touches a gage finger, the disk is warped and must be changed.
6. Swing disk fingers away from disk.

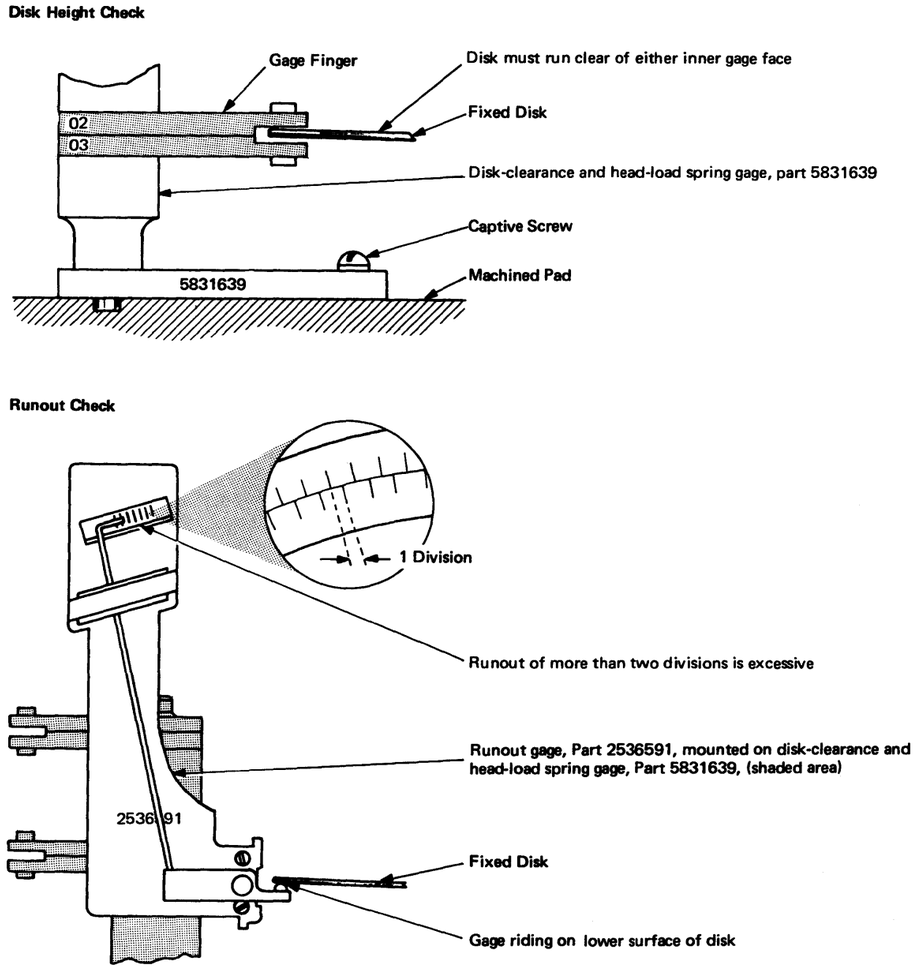


Figure 2-14. Disk Height and Runout Checks – Fixed Disk [07539]

7. Clip runout gage, part 2536591, on to pillar of disk-clearance and head-load spring gage below the 02 and 03 fingers. See Figure 2-14. Adjust height of runout gage so that its arm rides on lower surface of disk with the pointer at mid-scale.
8. Slowly rotate disk by the spindle pulley through one revolution and check runout. If pointer moves more than two divisions on the scale, runout is excessive and the disk must be changed.
9. Remove tools. Refit cable clamp pillar, head connectors, and fixed disk shield.
10. Re-install disk cartridge and top cover.

4.1.3.2 Cleaning

Clean both surfaces of the fixed disk as follows:

1. Remove top cover, disk cartridge and fixed disk shield.
2. Wrap a lint-free tissue around a disk and head cleaning paddle and dampen with isopropyl alcohol. See 2.3.2 for part numbers.
3. Insert paddle through head entry port, rotating the disk by turning spindle pulley. Keep the paddle horizontal and exert gentle pressure on disk surfaces while rotating.
4. Withdraw the paddle while disk is still rotating.
5. Dry the disk with a dry tissue in a similar manner to that for cleaning.

4.1.3.3 Removal

Before removing the fixed disk try to recover data contained on it. Refer to 1.5 if data transfer cannot be completed; if the disk is undamaged, see Figure 2-4 (head 02,03 replacement); for suspected HDI, see Figure 2-3.

Remove the fixed disk as follows:

1. Turn off power, ensuring first that carriage and disk cleaning brushes are fully retracted.
2. Open cartridge clamp arms and take off the disk cartridge.
3. Remove fixed disk shield by removing the screws.
4. Take off upper index transducer boom assembly (see 4.2.3.2).
5. Unscrew the eight screws around clamp ring (see Figure 2-15) and remove it. Store flat, protected by tissues, part 2200200.
6. Push down on one side of disk, hold other side, and lift out disk.
7. Scrap removed disk.

4.1.3.4 Replacement

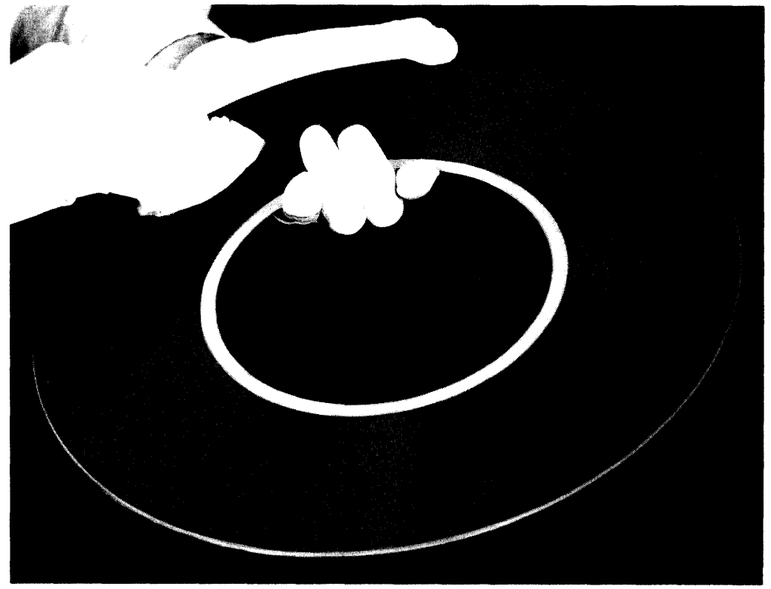
New fixed disks are supplied in a pack, part 2597938, that also contains nylon gloves, plastic washers, and a paper protector for the disk surface.

1. Thoroughly clean cavity in machine, using first a vacuum cleaner, then isopropyl alcohol-moistened tissues. (See 2.3.2 for part numbers of tissues and alcohol.) Wipe spindle chuck and clamp ring.
2. Open disk pack and put on nylon gloves.
3. Moisten a lint-free tissue with isopropyl alcohol.
4. Clean *lower* surface of disk with the tissue as shown in Figure 2-15, then dry the surface with dry tissues in a similar manner. (The disk has "TOP" written on the inner diameter to identify the upper surface.)
5. Still wearing nylon gloves, carefully place disk on spindle chuck without allowing the coated surface to touch any part of the machine.
6. Place clamp ring in position and, fitting new plastic washers provided, insert the eight screws. Do not trap the paper protector under the ring. Tighten the screws in sequence shown in Figure 2-15 with torque screwdriver, part 2597968.
   Note: Avoid dropping metal particles from the screw slots. Use a strip of adhesive tape for picking up particles.
7. Remove paper protector from disk. Remove nylon gloves.
8. Check the disk height and runout, see 4.1.3.1. If disk fails these checks, proceed as follows:
   a. Put on nylon gloves.
   b. Take off disk, rotate it through 90 degrees and reclamp as given in step 6. Remove gloves.
   c. Re-check disk height and runout. If still incorrect, fit a new disk.
9. Clean *upper* surface of disk with an isopropyl alcohol-moistened tissue. Dry with a dry tissue, then protect with a new tissue.
10. Re-install upper index transducer boom assembly (see 4.2.3.2). Fit fixed disk shield and adjust upper index transducer (see 4.2.3.1).

Before the 5444 can be used, perform any disk initialization program (that is in use) *five* times without error or alternate track assignment. If any alternate tracks are assigned, change the disk. (Three alternate tracks on each surface must be available to the customer on a newly fitted fixed disk.)

Inspect heads 02 and 03 after initialization for accumulation of oxide, and clean as necessary (see 3.2.2).

Cleaning Lower Surface of Disk



Sequence of Tightening Clamp Ring Screws

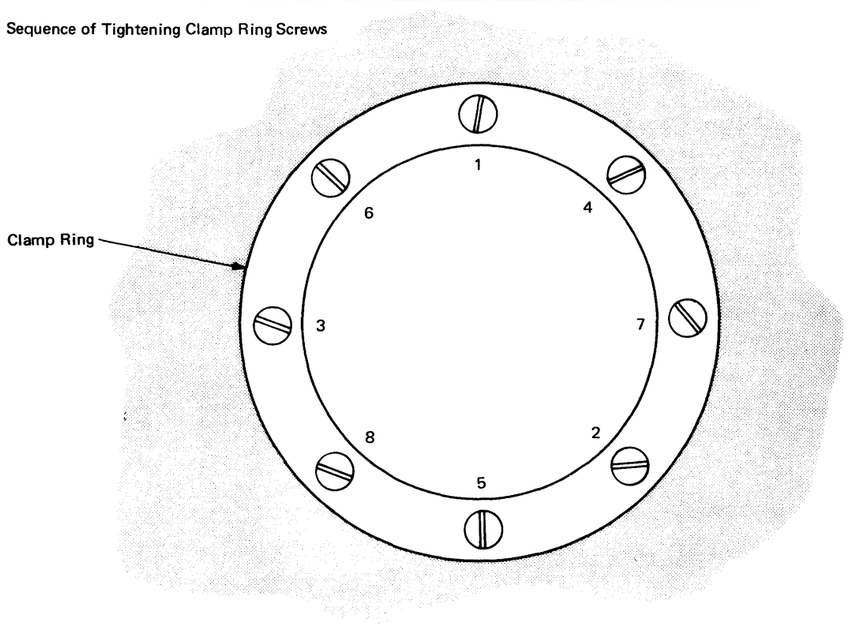


Figure 2-15. Replacement Details – New Fixed Disk [07540]

4.2 BASE ASSEMBLY

4.2.1 Cartridge Clamp Arm Replacement

Detach the left-hand and right-hand cartridge clamp arms by removing the three screws. Install the arms in the reverse manner.

4.2.2 Cartridge Interlock Switches

Each cartridge clamp arm assembly contains an interlock switch. To adjust the switches:

1. Remove disk cartridge.
2. Open cartridge clamp arms.
3. Detach the arms (see 4.2.1).

DANGER
The toggle spring assembly under each arm is under tension. Keep fingers clear when lifting, in the following step.

4. In turn, lift the toggle spring assembly for each arm (Figure 2-16) and feel the free play of 1/16 in. (1,6 mm). Adjust each interlock switch to operate in both directions within the free play, then tighten the switch screws.
5. Refit clamp arms and re-install disk cartridge.

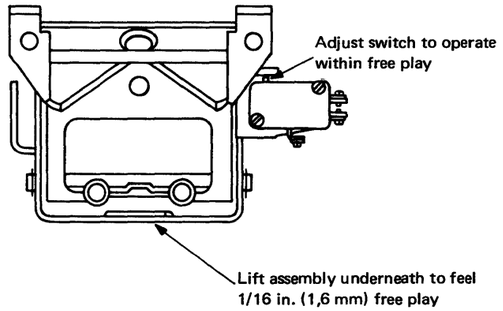


Figure 2-16. Adjusting Cartridge Interlock Switches [07541]

4.2.3 Upper Index Transducer

4.2.3.1 Checks and Adjustments

The following adjustments can be made to the upper index transducer assembly:

1. Vertical and horizontal (mechanical) adjustments.
2. Circumferential adjustments, using an oscilloscope.

Vertical and Horizontal Checks and Adjustments:

1. Turn off power and remove top cover.
2. Open cartridge clamp arms and remove disk cartridge.

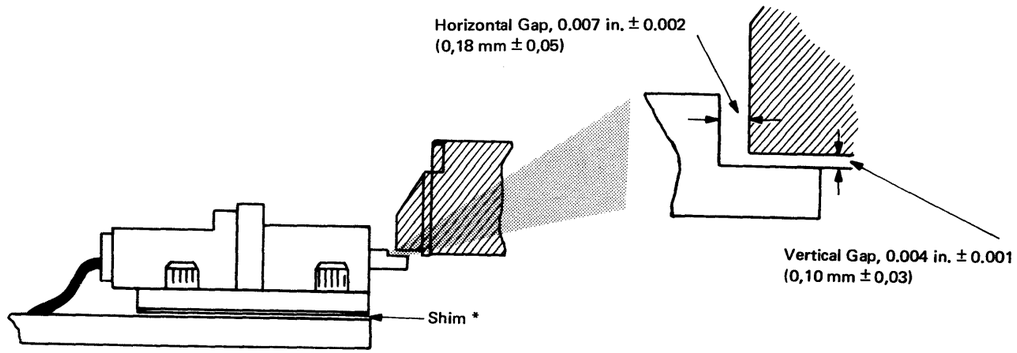
CAUTION
In the following steps, do not drop metal particles on to the fixed disk surface.

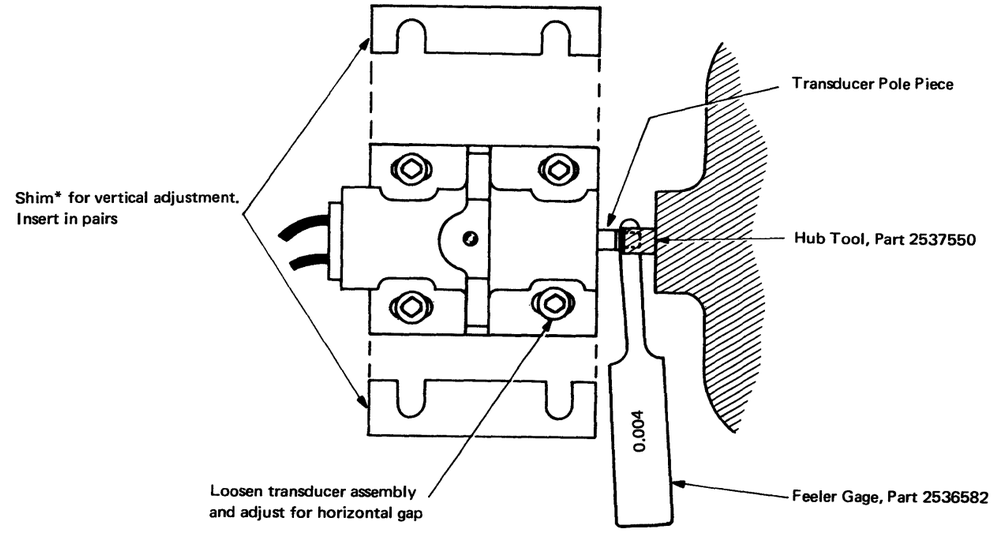
3. Place hub tool, part 2537550, on spindle, with projecting tip clear of transducer pole piece. Lower the handle and firmly locate tool.
4. Rotate hub tool until its tip overlaps transducer pole piece (Figure 2-17).
   Note: Make sure that the tip of the tool does not hit the pole piece.
5. Using 0.004 in. feeler gage, part 2536582, check that vertical gap between tip of hub tool and pole piece is 0.004 in. ± 0.001 (0,1 mm ± 0,03). Add or remove shims equally under either side of transducer assembly, as necessary.
6. Check that horizontal gap between pole piece and tip of hub tool is 0.007 in. ± 0.002 (0,18 mm ± 0,05). Adjust by slackening transducer mounting screws, moving transducer, and tightening screws.
7. Remove hub tool.
8. Carry out circumferential check.

Circumferential Check and Adjustment:

1. Insert CE cartridge, part 2537301 (see 2.3.3.2).
2. Start the 5444 and load to track 000.
3. Set CE mode-select switch to ₁ TRACK and forward/reverse switch to FORWARD. Go to track 005.
4. Set CE mode-select switch to HD0 or HD1.
5. Set the Tektronix 453 oscilloscope (using X1 probe) as follows:

   Channel 1: Y-W1 K6J12 (linear read signal 1; see ALD page FN260).
   Channel 2: Y-W1 K6J10 (linear read signal 2; see ALD page FN260).
   Trigger Positive: Y-W1 D6G03 (index pulse; see ALD page FN445).
   Mode: Add
   Channel 1: Normal. 50 millivolts per division.
   Channel 2: Inverted. 50 millivolts per division.
   Time/Division: 5 microseconds per division.





*Shims:

Part 5831988	0.002 in. (0,05 mm)
Part 5831989	0.003 in. (0,08 mm)
Part 5831990	0.008 in. (0,20 mm)
Part 5831991	0.020 in. (0,51 mm)

Figure 2-17. Upper Index Transducer – Vertical and Horizontal Adjustment [07542]

6. Loosen locknuts of circumferential adjustment screws and turn the screws in until they touch end of upper transducer boom (Figure 2-18).
7. Loosen clamp screw one half-turn. Open Y logic gate to allow screwdriver on to head of screw.
8. The oscilloscope display should resemble that shown in Figure 2-18; the marker pulse, which precedes a train of pulses by 10 μs, should occur 30 μs ± 5 from the start of the trace. To obtain this condition, back off one circumferential adjustment screw and tighten other screw so that boom is pivoted about the clamp screw. (If the right-hand screw is backed off and the left-hand screw is tightened, the marker pulse is moved towards the start of the trace, that is, the delay time is shortened.)
9. When marker pulse occurs within 25 to 35 μs, tighten clamp screw, then back off and lock both circumferential adjustment screws.
10. Stop machine and remove CE cartridge.
11. Re-check that the 0.004 in. ± 0.001 (0,1 mm ± 0,03) gap is still obtained between transducer pole piece and tip of hub tool; see "Vertical and Horizontal Checks and Adjustments".
12. Re-install top cover.

4.2.3.2 Removal and Replacement

An upper index transducer replacement kit is supplied as part 2598087, and consists of a transducer and shims. Remove the transducer as follows:

1. Take out disk cartridge.
2. Remove fixed disk shield. Place a lint-free tissue, part 2162567, between underside of the boom and surface of the fixed disk.
3. Remove the four screws that secure transducer boom cover plate, and take off plate. Unplug connector P1.
4. Remove the four socket screws that hold transducer assembly, and lift off the assembly. Take care not to lose the shims beneath (see Figure 2-17). Remove tissue.

Install transducer and shims in reverse order to removal. Check the adjustment (see 4.2.3.1).

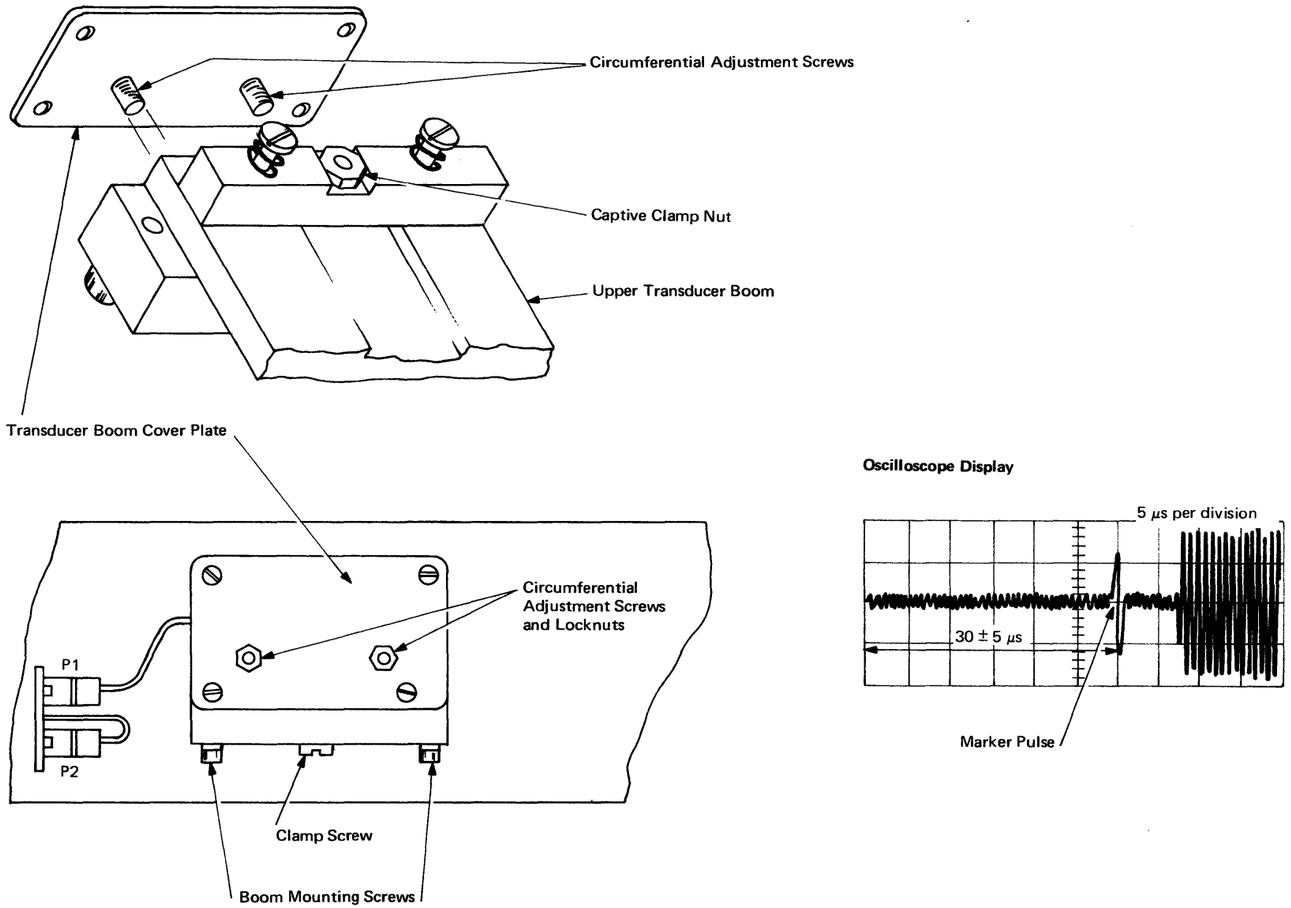


Figure 2-18. Upper Index Transducer – Circumferential Adjustment [07543]

4.2.4 Lower Index Transducer

4.2.4.1 Check and Adjustment

The lower index transducer assembly is mounted on the main spindle casting. Check and adjust as follows:

1. Open Y logic gate to gain access.
2. Check that gap between transducer and metal nib on spindle pulley (Figure 2-19) is 0.002 in. ± 0.001 (0,05 mm ± 0,03).
3. Slacken mounting screws of transducer, adjust as necessary to obtain correct gap, and tighten screws.
4. Close Y logic gate.

4.2.4.2 Removal

Note: Recover any required data from the fixed disk before the lower index transducer is removed.

Remove transducer as follows:

1. Open Y logic gate.
2. Without disturbing transducer housing, release hexagon setscrew that holds transducer (see Figure 2-19).
3. Withdraw transducer from its housing. Unplug connector P2 and cut leads back to the cable loom at both ends.

4.2.4.3 Replacement

A lower index transducer replacement kit is supplied as part 2598086.

1. Insert transducer into housing. Route and tape the leads alongside the cable loom. Plug in connector P2.
2. Adjust transducer (see 4.2.4.1).
3. Using the replacement long hexagon screw and locknut, secure transducer without overtightening. Lock the screw.
4. Close Y logic gate.
5. Retrieve any data that has still to be recovered from the fixed disk.
6. Re-initialize the fixed disk by running the disk initialization program *five* times without errors or alternate track assignment.

4.2.5 Air Filter

Handle air filter with care and prevent it from becoming dirty. A dirty filter shortens the life of disks and read/write heads.

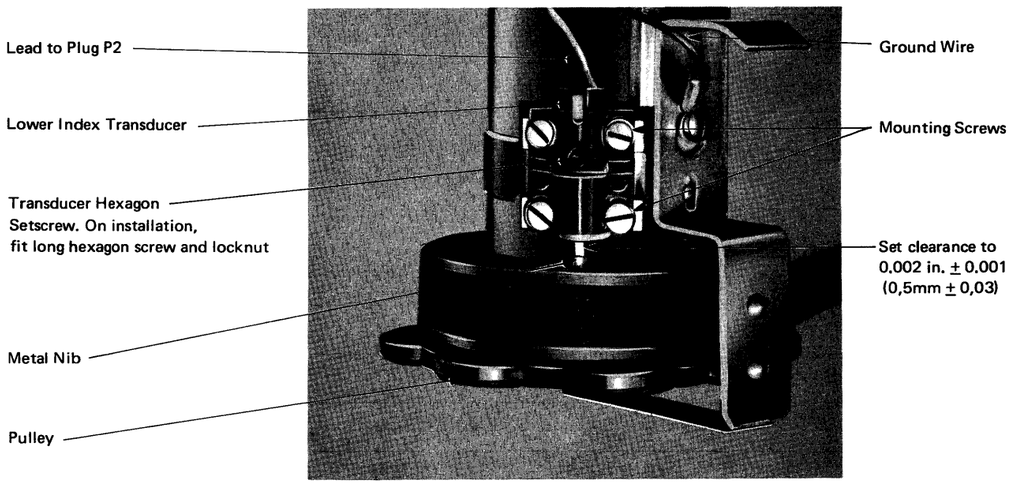


Figure 2-19. Lower Index Transducer [07544]

4.2.5.1 Service Check

Examine the filter whenever any service or removal is done. Look for dirt and breaks in the material. Change a dirty or defective filter; do not attempt to clean or repair it.

4.2.5.2 Removal

1. Remove top cover from machine.
2. Unscrew filter mounting screws (Figure 2-20).
3. Lift out filter. Block the air duct beneath filter assembly with a lint-free tissue, part 2162567, to prevent objects falling in.
4. If filter is serviceable, carefully store it.

4.2.5.3 Replacement

1. Remove tissue from air duct.
2. Install new filter and fit mounting screws (see Figure 2-20).
3. Fit top cover to machine.

4.2.6 Changing Drive Motor

DANGER
Always turn off power before working on the drive motor, because the motor contains a thermal cutout for restoring power after overheating.

Change the drive motor (see Figure 2-47) as follows:

1. Take off drive belt (see 2.4.7).
2. Disconnect motor leads at terminal block TB1, capacitor C1, and ac box ground.
3. Remove motor mounting screws under the bracket.
4. Replacement motors are supplied complete with leads and connectors. Install motor and secure with its mounting screws.
5. Connect appropriate leads to TB1, C1, and ac box ground (see ALD page ZA200).
6. Refit drive belt (see 4.2.7).

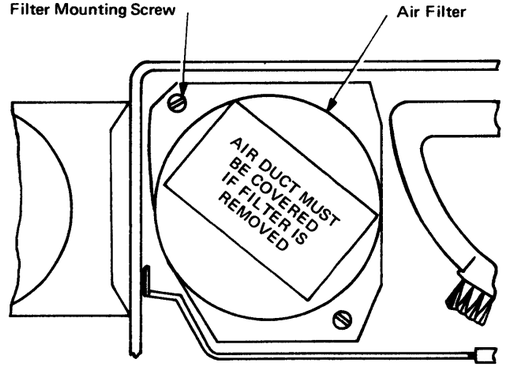


Figure 2-20. Air Filter Mounting [07545]

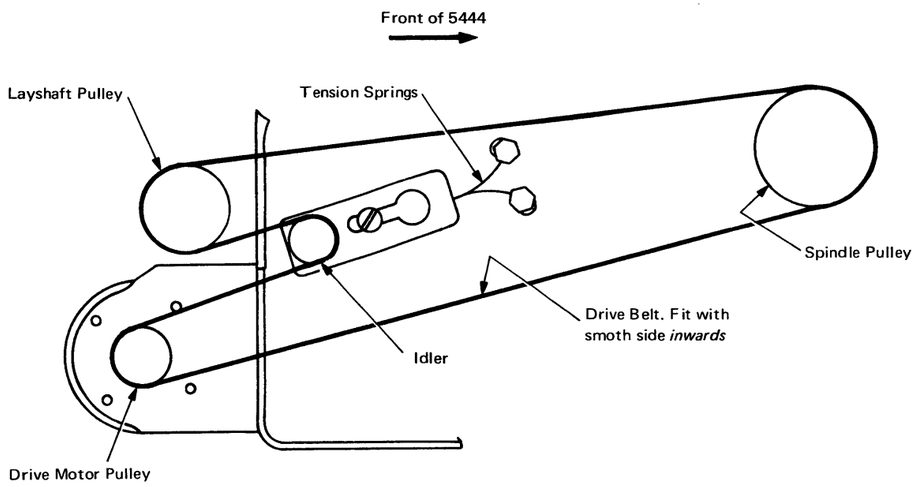


Figure 2-21. Route of Drive Belt [07546]

4.2.7 Changing Drive Belt

Change the drive belt if it is cracked or frayed, as follows:

1. The belt is self-adjusting. To remove, first release tension from idler (Figure 2-21) by pulling against tension springs, then lift off belt.
2. Fit belt with its smooth side inwards.
3. Adjust drive motor pulley on its shaft by loosening the hexagon screw, so that belt runs clear of flanges on other pulleys. Tighten motor pulley screw on completion.

Note: If the 5444 is mounted with a limited accessibility to the underside, tape the drive belt to the spindle pulley (see Figure 2-21) with adhesive tape. This action will allow the CE to move to the other end of the machine for pulling the belt through to the other pulleys. Remove the tape on completion.

4.2.8 Spindle Assembly

Before commencing work on the spindle assembly, make all attempts to recover data from the fixed disk. Refer to Figure 2-3.

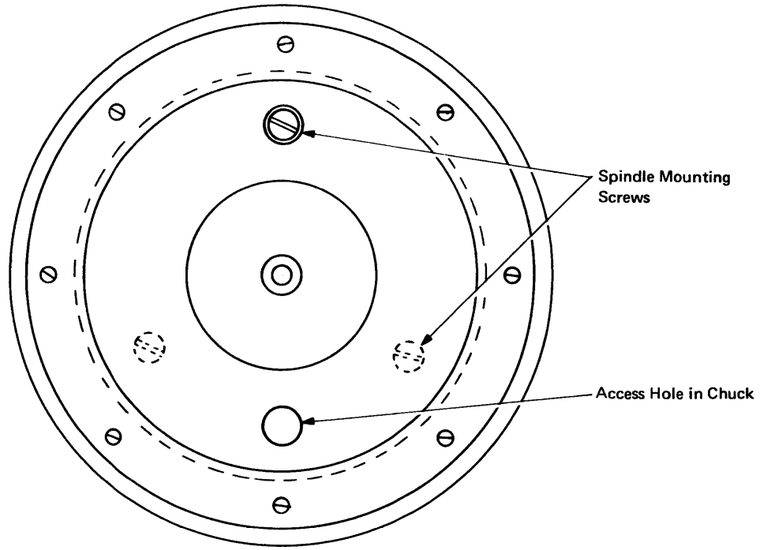
4.2.8.1 Removal

1. Ensure that carriage is fully retracted, then turn off power.
2. Remove disk cartridge, the shield above fixed disk, and upper index transducer boom assembly (see 4.2.3.2).
3. Remove and discard fixed disk (see 4.1.3.3).
4. Take off drive belt (see 4.2.7).
5. Open Y logic gate.
6. Remove anti-static assembly and ground wire from spindle (Figure 2-22), and lower index transducer assembly (see 4.2.4.2).
7. Lift magnet ring out of the chuck (see Figure 2-22) with a screwdriver, without damaging the ring.
8. Turn chuck until one of the three spindle mounting screws is visible through an access hole.
9. Unscrew mounting screw, completely lifting it out with a screw-holding driver. Turn chuck until another screw is visible and remove that screw in same way. Repeat the action for the third screw.

CAUTION
Do not "lever" the spindle assembly with a screwdriver (in the following step) or else the machined base may become damaged.

10. Lift out spindle assembly by gripping edges of chuck plate.

Top View



Side Section

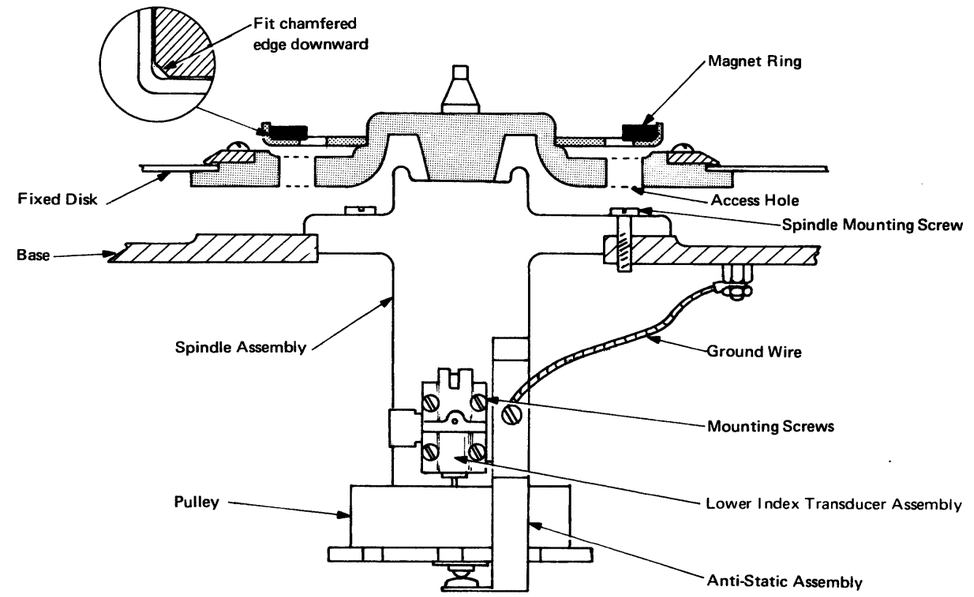


Figure 2-22. Spindle Assembly [07547]

4.2.8.2 Replacement

Replace the spindle assembly as a complete unit.

1. Insert spindle assembly (see Figure 2-22) into machine, with lower transducer mounting facing towards Y logic gate.
2. Place assembly firmly on machined base. Turn spindle chuck until the hole for one mounting screw is visible. Use a screw-holding driver to start the mounting screw and lightly tighten. Repeat this action to fit the other two mounting screws.
3. Tighten all three screws down evenly. Refit magnet ring, with chamfered edge downwards as shown in Figure 2-22.
4. Refit anti-static assembly and connect ground wire.
5. Refit lower index transducer assembly (see 4.2.4.3), then adjust it (see 4.2.4.1).
6. Refit drive belt (see 4.2.7).
7. Fit a new fixed disk (see 4.1.3.4, steps 1 through 9).
8. Refit upper index transducer boom (see 4.2.3.2).
9. Refit shield above fixed disk.
10. Check upper index transducer clearances, and adjust if necessary (see 4.2.3.1).
11. Check actuator alignment (see 4.4.1.3).
12. Align read/write heads 00 and 01 and set heads 02 and 03 to initial setting of 0.025 in. (0,64 mm). See 4.7.1.3.
13. Install disk cartridge.
14. Initialize the new fixed disk.

4.3 DISK CLEANING BRUSHES

4.3.1 Brush Arm Assembly

To check that the brush arm is in the fully retracted position, view the assembly through the small window in the top cover.

4.3.1.1 Check

Check that brushes are not worn so that they cannot be deflected as they pass over the disk (Figure 2-23). If worn, change (see 4.3.1.2).

4.3.1.2 Removal and Replacement

Change the brushes during preventive maintenance and if they are worn, as follows:

1. Turn off power and remove top cover.
2. Take off clip from brush arm support and lift off brush arm (see Figure 2-23). Take care not to damage the clip.
3. Unclip brushes from end of brush arm and slide on new brushes.
4. Mount brush arm and secure with clip.
5. Refit top cover.

4.3.2 Brush Mid-Cycle Switch and Brush Cycle-Complete Switch

4.3.2.1 Adjustment

1. Turn off power and remove top cover.
2. Remove air filter (see 4.2.5.2).
3. Unclip and take off brush arm (see Figure 2-23). Take care not to damage the clip. Remove brush motor cover plate.
4. With cam arm on retracted stop (Figure 2-24), check gap between bodies of the brush mid-cycle and brush cycle-complete switches and the cam surface. The clearance should be 0.050 in. (1,27 mm).
5. To adjust switches, slacken off pivot screw and mounting screw of each switch and move the switch. (The nuts below the screws are captive.)
6. Check the order in which the switches operate, as follows:
   a. By hand, slowly move cam arm from retracted stop to forward stop, and check that cycle-complete switch transfers before mid-cycle switch does.
   b. By hand, slowly move cam arm from forward stop to retracted stop, and check that mid-cycle switch transfers before cycle-complete switch.
   c. Vary the 0.050 in. (1,27 mm) gap by ± 0.003 in. (0,86 mm) to obtain these conditions.
7. Refit the following items:
   a. Brush motor cover plate.
   b. Brush arm.
   c. Air filter (see 4.2.5.3).
   d. Top cover.

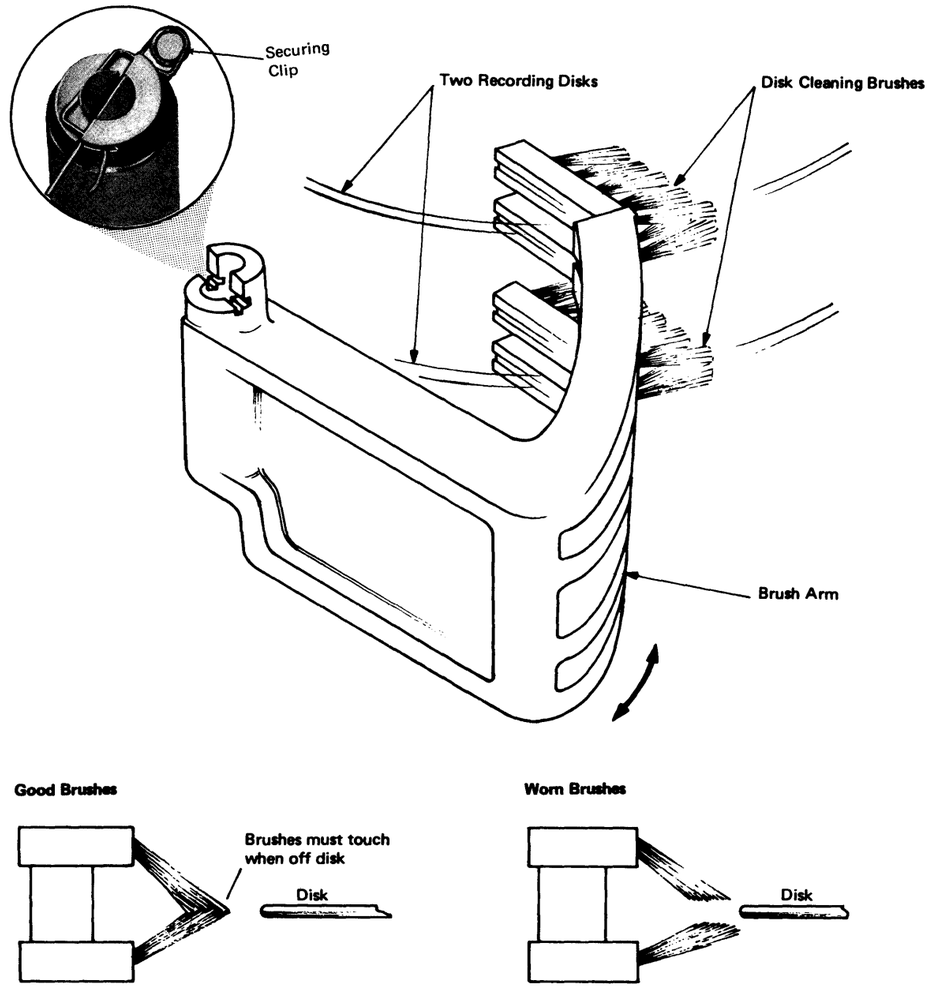
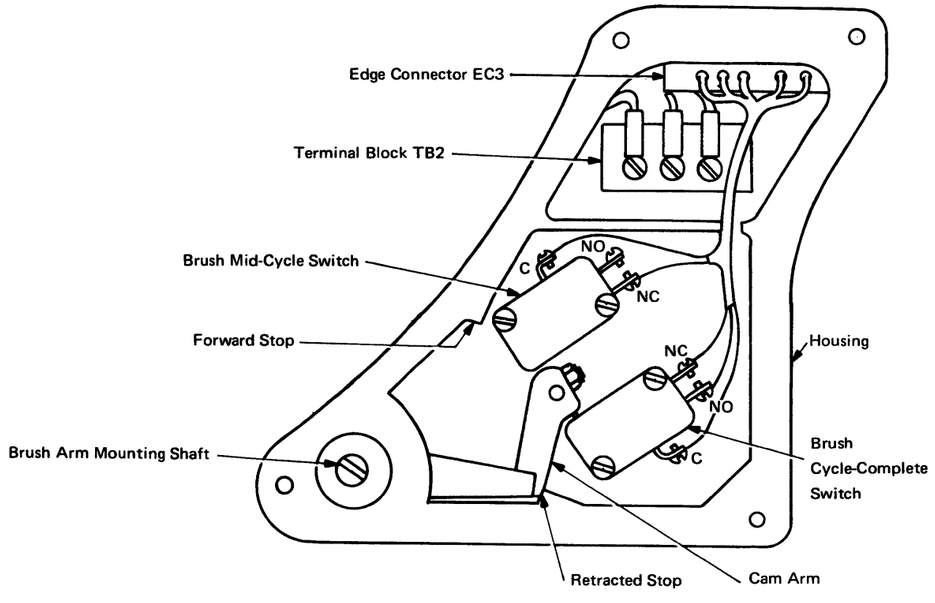
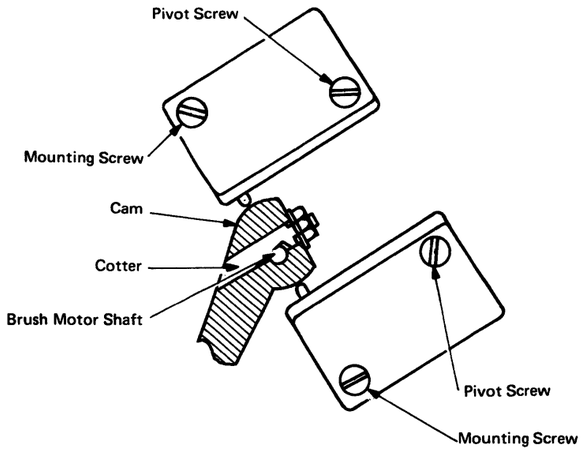


Figure 2-23. Condition of Disk Cleaning Brushes [07474]

Brush Motor Switch Assembly



Switch Adjustment



Detail of Adjustment

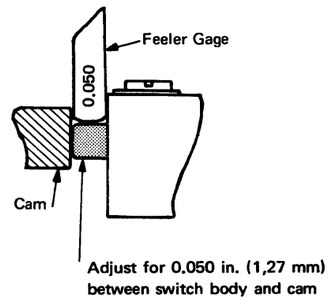


Figure 2-24. Disk Cleaning Brush Drive – Switch Adjustment [07548]

4.3.2.2 Removal and Replacement

1. Turn off power and remove the following items:
   a. Top cover.
   b. Brush motor cover plate.
2. Note wiring to switch, then disconnect (see Figure 2-24).
3. Unscrew switch mounting and pivot screws. (The nuts below the screws are captive.) Lift off switch.
4. Install new switch in reverse sequence to removal. Check adjustment (see 4.3.2.1).

4.3.3 Brush Motor

4.3.3.1 Removal

1. Turn off power and remove top cover.
2. Remove air filter (see 4.2.5.2). Block air duct and brush entry port with lint-free tissue, part 2162567.
3. Unclip and take off brush arm (see Figure 2-23). Do not damage clip.
4. Remove brush motor cover plate.
5. Disconnect motor leads at terminal block TB2 and switch connections at edge connector EC3 (see Figure 2-24).
6. Take out the four screws at corners of moulded housing, then lift out housing assembly.
7. Loosen cotter nut (see Figure 2-24). Tap cotter to release it from brush motor shaft.
8. Unscrew motor mounting screws and take out motor. Do not lose the cam.

4.3.3.2 Replacement

Note: When changing a brush motor, make sure that the new motor is of the correct frequency for the power supply.

1. Insert cam cotter (see Figure 2-24), turning motor shaft so that its flat side engages cotter. Fit and tighten the nut. Assemble cam arm peg into link.
2. Fit motor and secure with its screws.
3. Check adjustments of brush mid-cycle and cycle-complete switches (see 4.3.2.1).
4. Re-install assembly, and the items taken off in 4.3.3.1, without trapping the wires. (See ALD pages ZZ200, ZA200, and ZA220, for wiring details.) Ensure that tissues are removed from air duct and brush entry port before fitting air filter.

4.4 ACTUATOR ASSEMBLY

4.4.1 Actuator Components — Handling

Carriage or leadscrew parts (Figure 2-25) are not field replaceable units; if they are defective, change the complete actuator assembly. Handle and store all parts of the actuator assembly with extreme care. In particular, keep the leadscrew, follower wheels, linear ball slides, drive disk, and drive tire free of damage or contamination.

4.4.1.1 Removal

If data is to be recovered from the fixed disk, do this before actuator removal, if possible; otherwise, refer to 1.5 to attempt recovery after actuator replacement.

A T-handle wrench, part 460947, is held at branch offices to facilitate actuator screw removal where enclosures make entry to the base of the 5444 difficult.

1. Turn off power.
2. Remove drive belt (see 4.2.7). This action allows the idler to retract and give access to hexagon socket screws that hold actuator.
3. Disconnect plugs J3, J4, and J5 from dc box.
4. Ensure that carriage is fully retracted then remove read/write head arms (see 4.7.1.4).
5. Disconnect head-load cable (see 4.8.1.2).
6. Open CE panel (on dc box cover) and hinge back to allow room for actuator assembly to be withdrawn. Remove motor upper oiling spout from drive motor.
7. Remove three actuator holding screws (using T-handle wrench, part 460947), slightly lift actuator assembly to bring its locating dowel clear of base casting, and carefully withdraw assembly.
8. Protect assembly in a dust-proof bag while out of the machine.

4.4.1.2 Replacement

Only actuator assemblies with adjustable layshafts are supplied to the field for replacement.

Note: The carriage inner limit stop shaft on the actuator casting (see Figure 2-25) is factory-set to track 207½ and should only be moved during conversion for a 5444 Model 1 (see 4.4.2) or during actuator alignment on a Model 1 (see 4.4.1.3).

1. Check that read/write head arms are removed and that carriage is fully retracted.
2. Make sure that mating faces of actuator and base casting are clean. Insert actuator assembly through casting and locate by the dowel (see Figure 2-26).
3. Hand tighten the three socket holding screws. Use T-handle wrench, part 460947, if necessary.
4. Refit upper oiling spout on drive motor, with the hollow facing downwards.
5. Proceed with alignment, see 4.4.1.3.

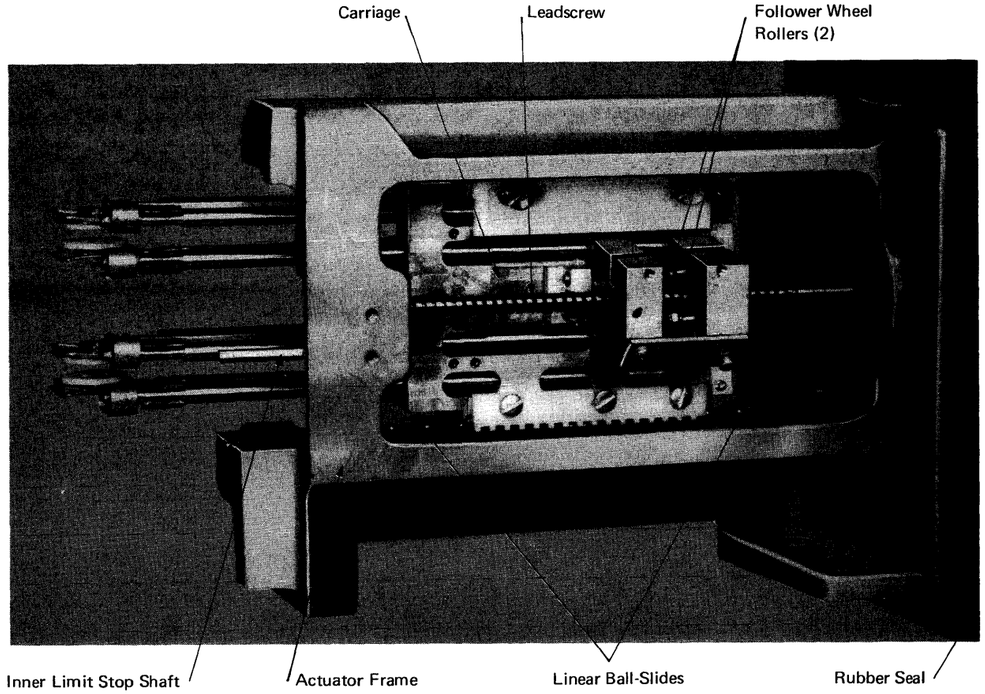


Figure 2-25. Actuator Carriage Assembly [07478]

4.4.1.3 Alignment

The actuator assembly must be aligned so that the carriage moves in a true radial line to the disk. A hub tool, part 2537550, and an actuator alignment tool, part 5831644, are available at branch offices for aligning the actuator assembly.

Note: On 5444 Model 1 (103 tracks only), remove the inner limit stop shaft (see Figure 2-25) and the carriage overrun interlock switch to allow the carriage to extend to track 200. The drive disk *and* the inner limit stop shaft must not be loose at the same time.

1. Check that carriage is fully retracted, then remove disk cartridge and machine top cover.
2. Ensure that actuator assembly is firmly on base casting but is free to pivot on dowel (Figure 2-26).
3. Place hub tool, part 2537550, on main spindle.

CAUTION
Avoid damaging the head-load spring in the following step.

4. Back off adjusting screw of top head arm. Fit actuator alignment tool, part 5831644, in the top (00) position (see Figure 2-26); register the tool snugly on the locating faces. Fit one R/W head arm in position 01 to balance the clamp. Fit clamp and tighten clamp screw.
5. Extend carriage to track 200.

CAUTION
From this step onwards, the fixed disk is at risk. If the actuator assembly is allowed to lift off the base, the head-load springs will damage the fixed disk.

6. Adjust the actuator assembly sideways, with a 0.002 in. (0,05 mm) feeler gage between actuator alignment tool face and hub tool boss. The gap should be 0.002 in. ± 0.001 (0,05 mm ± 0,03). A suggested method of moving the actuator assembly is to press the detent plate (see Figure 2-27) with the thumbs, against the rubber seal (see Figure 2-25).
7. Tighten the three socket holding screws. *The tightening sequence is important.* As the screws are tightened, the actuator assembly tends to pivot about the locating dowel. Finger-tighten all three screws, then:

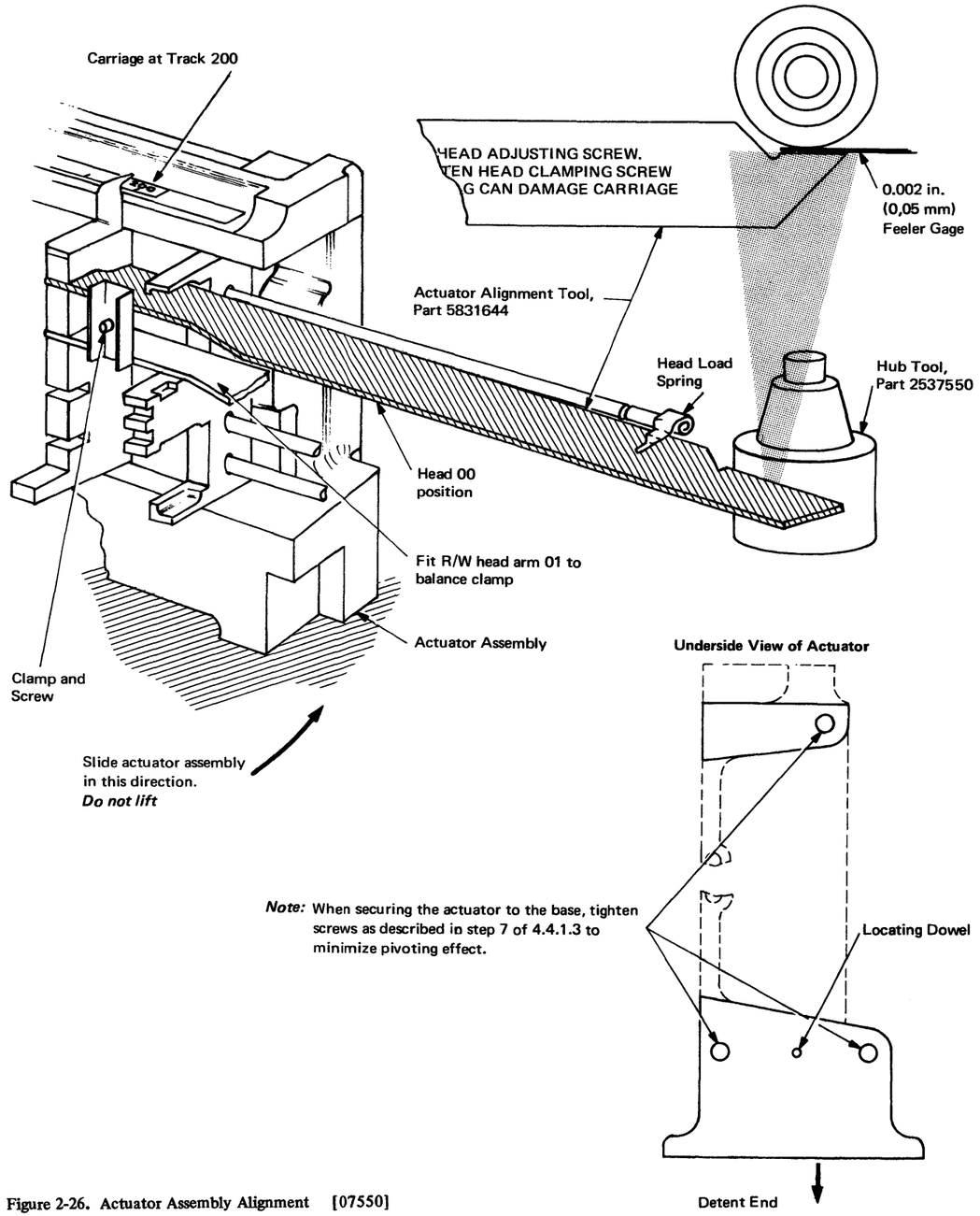


Figure 2-26. Actuator Assembly Alignment [07550]

   a. Tighten the single screw nearest the disk and observe which way the 0.002 in. gap moves.
   b. Select one of the two screws near the detent end and tighten it so the gap moves in the opposite direction.
   c. Continue to work on these two screws alternately until the gap remains constant at 0.002 in.
   d. Tighten the third screw and check the gap.

8. Retract carriage and remove tools.
9. On 5444 Model 1, refit and adjust inner limit stop shaft and carriage overrun interlock switch (see 4.4.2).
10. Reconnect head-load cable and adjust (see 4.8.1.2 and 4.8.1.1).
11. Refit read/write head arms and adjust (see 4.4.3, 4.7.1.5, and 4.7.1.3).
12. Connect plugs J3, J4, and J5 to dc box.
13. Fit drive belt (see 4.2.7).
14. Check upper index transducer setting and adjust as necessary (see 4.2.3.1).

4.4.2 Replacement Actuator Assembly – Limit Stop (5444 Model 1)

Replacement actuator assemblies are supplied with the inner limit stop set to track 207½. On the 5444 Model 1 (two disks limited to track 103 only), adjust the inner limit stop shaft to track 107½ and set the carriage overrun interlock switch to transfer 2½ to 3 tracks before the mechanical stop. Proceed as follows:

1. Check that drive disk is in adjustment by moving carriage to inner limit stop shaft (see Figure 2-25). The track-crossing sensor hole should be between the '7' and '8' slots in the drive disk. The carriage scale pointer should indicate over 200.
2. Lift out shield located near air filter. Stop shaft is set in actuator casting, at the end nearest to heads.
3. Move carriage to track 107½ (that is, carriage scale just past 100, and track-crossing hole between the '7' and '8' slots of drive disk). At inner limit stop shaft, loosen lower six-flute setscrew (7/64 in. wrench) and move stop shaft to limit carriage travel at track 107½. Tighten setscrew and refit shield.
4. Set carriage overrun interlock switch to transfer 2½ to 3 tracks before inner limit stop (see 4.5.7.1).

4.4.3 Replacement Actuator Assembly – R/W Heads (5444 Model 3)

If a replacement actuator assembly is being fitted to a 5444 Model 3 (removable disk only), read/write head arm assemblies are fitted in the upper two positions (00 and 01) only. Positions 02 and 03 must be occupied by blank arms to hold off the head springs: position 02 is fitted with arm B down (downward-facing head), part 2536625, and position 03 with arm B up (upward-facing head), part 2536626. Retract the carriage before fitting these arms, and locate the head-load springs on the raised portion of the arms.

Note: The head-load spring adjustments *at all four positions* must still be correct when blank arms are fitted (see 4.8.4.1).

4.5 ACCESS MECHANISM

4.5.1 Layshaft

The layshaft assembly is lubricated for life and is not to be dismantled. If any failure demands that a layshaft assembly be changed, fit also a new late level (after EC level 391962) actuator assembly, part 2598200 (a late level actuator assembly complete with layshaft, together with fitting instructions and machine record update). Early level layshafts cannot be replaced. Some earlier units have a different type of layshaft and drive tire. Later units, from EC level 391962, have an adjusting screw on the layshaft casting (Figure 2-27). The two types are not interchangeable.

4.5.1.1 Establishing Clutch Relationship – Summary of Action

To establish the correct clutch/drive disk/layshaft relationship:

- **The drive disk and tire are removed, and the relationship between the lower clutch pad and the leadscrew is then set, with a clutch setting gage.**
- **The tire is fitted and the layshaft is set with a gap between the lower clutch pad and the tire driving surface.**
- **The layshaft is secured and the upper clutch is set a fixed distance from the tire upper driving surface.**
- **The tire is again removed and the drive disk is refitted.**
- **The tire is finally refitted and the clutch settings are rechecked.**

Once the initial settings have been made, any one unit can be moved, replaced, and set relative to the other undisturbed unit. For example, a new layshaft can be installed and set to the lower clutch, providing the clutch has not also been moved.

4.5.1.2 Adjustment

1. Turn off power and remove detent cover. Remove drive belt (see 4.2.7).
2. Loosen clutch brackets and use the eccentrics to move both brackets to the rear, that is, clear of drive disk.
3. Remove drive tire and drive disk. Using drive disk screw, secure clutch setting gage, part 2597940, on end of leadscrew (Figure 2-28).
4. Adjust lower clutch assembly forward until 'GO' part of the gage clears lower clutch pad, but 'NO GO' part does not pass. The adjustment is fine because the difference between 'GO' and 'NO GO' is only 0.002 in. (0,05 mm). Use only light finger pressure to turn gage with detent pawls hooked back.
5. Remove gage and install drive tire.

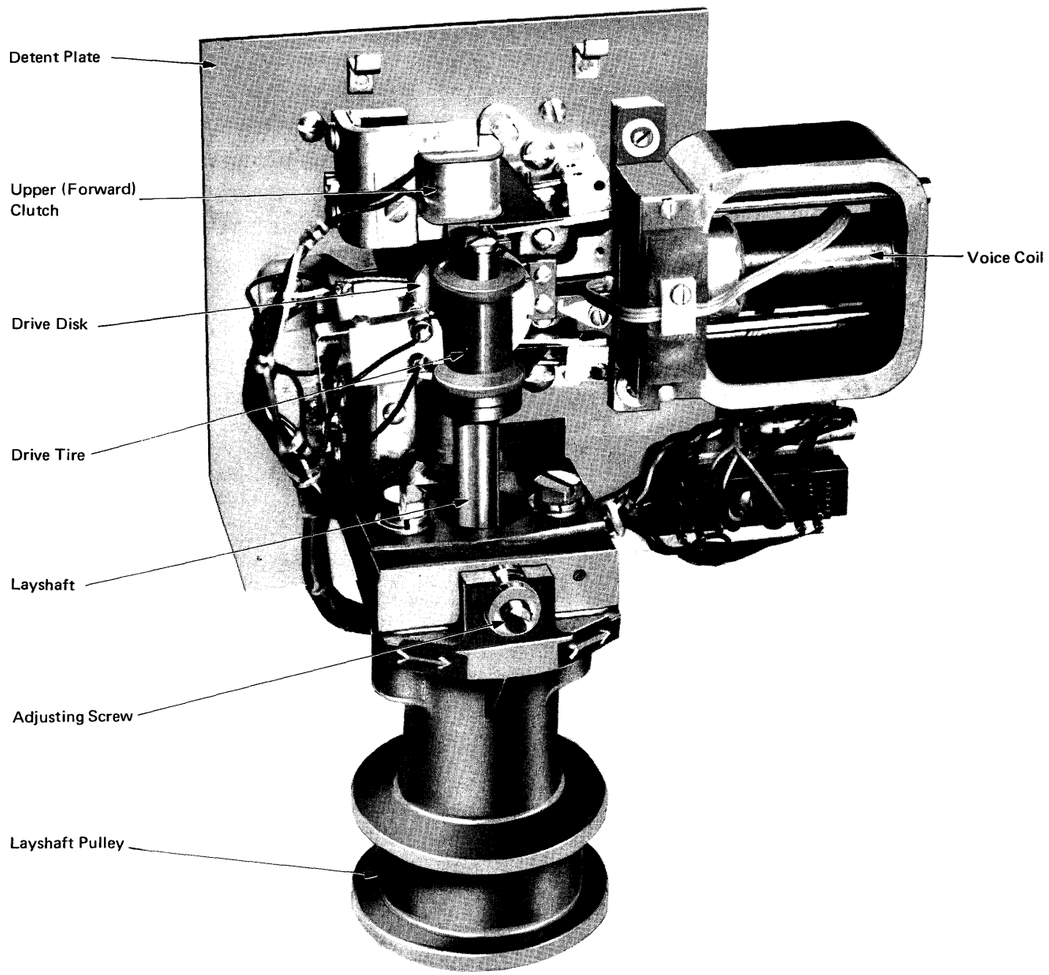
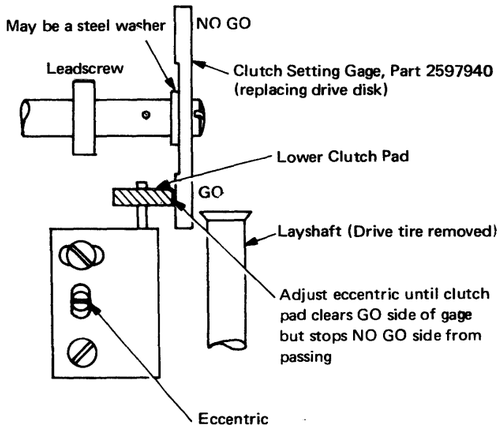


Figure 2-27. Layshaft Assembly (EC Level 391962) [07549]



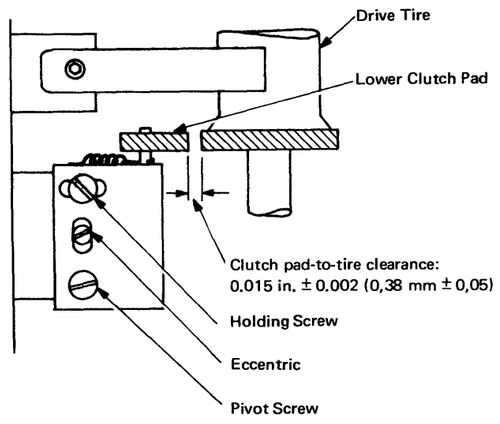


Figure 2-28. Lower Clutch Initial Setting [07551]

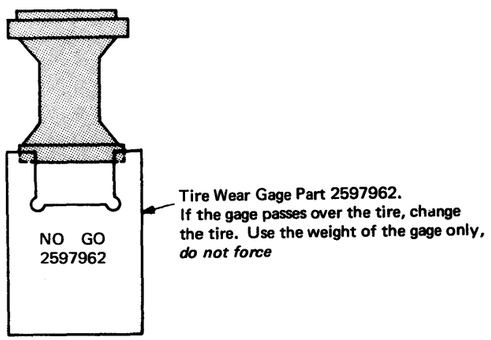


Figure 2-29. Checking Tire Wear [07552]

6. Adjust layshaft assembly for a 0.015 in. ± 0.002 (0,38 mm ± 0,05) between the lower driving surface of tire and the lower clutch pad (see Figure 2-28). Most layshaft assemblies have an adjusting screw, but the early version has no adjuster and must be lightly tapped forward with a screwdriver handle.
7. Tighten layshaft assembly and check the adjustment by inserting a 0.013 in. (0,33 mm) feeler gage between tire and lower clutch pad; the gage should pass through. Insert a 0.017 in. (0,43 mm) feeler gage; as it enters, the tire should rotate.
8. Set upper clutch assembly for a 0.015 in. ± 0.002 (0,38 mm ± 0,05) gap between upper clutch pad and tire upper driving surface. Check with 0.013 in. and 0.017 in. feeler gages as in step 7.
9. Remove tire. Clean and fit, if necessary, a new drive disk with a new brown washer (see Figure 2-30). Recheck clutch clearances.
10. Refit tire and clean it with isopropyl alcohol, part 2200200.
11. Refit drive belt (see 4.2.7), unhook the yoke and fit the detent cover.

4.5.1.3 Removal and Replacement

Before removing the layshaft assembly:
1. Turn off power.
2. Remove detent cover.
3. Remove drive belt (see 4.2.7).

Removal of Assembly (prior to EC Level 391962) : Loosen the holding screws and draw the assembly out from the casting; do not tilt the assembly or else the tire will damage the drive disk. Do not lose the shims.

Removal of Assembly at EC Level 391962: Remove the drive tire. Unscrew the layshaft holding screws and take the layshaft assembly downward and out. The adjusting screw may have to be backed off to allow removal.

Replacement:
Note: The replacement of an early-level layshaft assembly by a later-level assembly involves an actuator change as described in 4.5.1.
Fit the layshaft assembly as follows:
1. Replace layshaft assembly in the reverse sequence to removal, installing the original shims and *hand-tightening* the holding screws.
   Note: If shims are lost or damaged, their thickness is marked on the actuator casting; use shim 0.005 in. (0,13 mm), part 2536351, and shim 0.015 in. (0,38 mm), part 2536475.
2. Adjust as described in 4.5.1.2. If lower clutch assembly has not been disturbed, set tire lower driving surface to 0.015 in. (0,38 mm) from clutch pad.
3. Refit drive belt (see 4.2.7) and detent cover.

4.5.2 Drive Tire

4.5.2.1 Check

Check both driving surfaces of the tire for wear with the tire wear gage, part 2597962, as shown in Figure 2-29.
Visually inspect the tire surfaces for:
1. Staining or polishing of the driving edge.
2. Ragged edges or tapered driving surface.

4.5.2.2 Removal and Replacement

If an early-level tire, part 2537598, is being changed, order the new one from one of the following manufacturing plants; quote "MES Code 3" on the order. (This tire is not stocked at field part centers.)
1. Dept. 625, IBM Corporation, Monteray and Cottle Roads, San Jose, California 95114, U.S.A.
2. Dept. 611, IBM United Kingdom Ltd., Langstone Road, Havant, Hampshire, England.

The early-level tire is not interchangeable with a later tire.

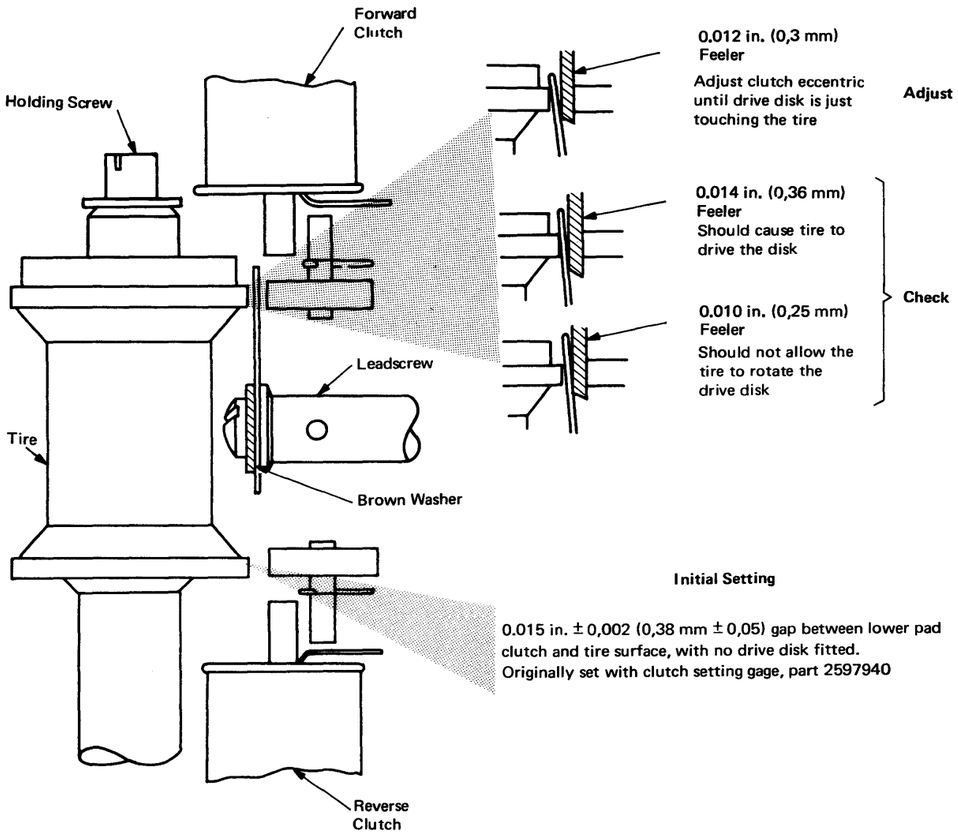


Figure 2-30. Clutch Adjustment and Checking [07553]

Remove the tire holding screw and withdraw the tire assembly. Take care not to damage the drive disk.

Fit the tire in the reverse sequence to removal. When a new tire replaces a worn one, check the tire-to-lower clutch pad clearance as follows:

1. Hold back yoke with holdout hook, to disengage detent pawls.
2. Insert a 0.012 in. (0,3 mm) feeler gage between lower clutch pad and drive disk (Figure 2-30). The disk should touch the tire driving surface for one complete layshaft revolution. Adjust as necessary.
3. Check by inserting a 0.010 in. (0,25 mm) feeler gage and turning the tire with the layshaft pulley; drive disk should not rotate.
4. Insert a 0.014 in. (0,36 mm) feeler gage. Turn the tire, and check that the disk is driven by the full circumference of the tire driving surface.
5. Make any further adjustments by loosening and adjusting the layshaft.

4.5.2.3 Cleaning

DANGER
Do not attempt to clean the tire when the 5444 is running.

Clean the tire after any activity. Apply isopropyl alcohol, part 2200200, with a lint-free tissue, while rotating the layshaft by hand.

4.5.3 Drive Disk

CAUTION
The drive disk is easily damaged. Take care, therefore, when working near or cleaning it. Clean the disk with isopropyl alcohol after any activity to prevent the transfer of contaminants to the drive tire.

4.5.3.1 Service Check

A drive disk that is buckled or is dished (that is, concave or convex) cannot perform correctly. Move the carriage, with the yoke disengaged, and view the disk from the side; when the disk is turning, any unevenness will be apparent. Change a suspected drive disk.

4.5.3.2 Removal

1. Turn off power.
2. Remove detent cover.
3. Disengage detent pawls by hooking back the yoke.
4. Remove drive tire (see 4.5.2.2).
5. Turn leadscrew to gain access to the hole between drive disk and detent wheel.

CAUTION
Make sure that, in the following step, the inner limit stop shaft *and* the drive disk are not loose at the same time; the setting of the drive disk depends on the setting of the stop shaft.

6. Insert a suitable six-flute wrench into the 3/32 in. (2,4 mm) hole shown in Figure 2-31. Unscrew disk-holding screw, using wrench to steady the leadscrew. Ensure that pawls are clear of detent teeth during this operation; any attempt to unscrew the disk with pawls engaged will permanently damage them.

4.5.3.3 Replacement

Note: On some early machines, a steel washer is fitted behind the drive disk (see Figure 2-28). On replacement of the disk, face the countersunk side of the washer towards the leadscrew.

1. Clean drive disk with lint-free tissue dampened with isopropyl alcohol. Holding disk by its edges, place it on leadscrew shoulder; put a *new* brown washer, part 5831904, between disk and screw (see Figure 2-31). Tighten lightly.
2. If fine-home sensor mask has been moved, reposition mask to obtain a clearance to drive disk of 0.010 to 0.030 in. (0,25 to 0,76 mm).
3. Set sensor support bracket to center of adjustment slot.
4. Disengage detent pawls and slide carriage to inner limit stop shaft, which is set to track 207½ position (5444 Models 2 and 3) or track 107½ position (Model 1).
5. Release detent pawls and let them detent at track 207 or 107 position, as appropriate.
6. With disk-holding screw slack, rotate drive disk until the '7' slot is aligned with track-crossing hole in sensor mask. Rotate a small amount counterclockwise to anticipate turning motion when the disk is tightened (see Figure 2-31); rotate the disk only from the edge, because skin acids contaminate the disk face.
7. Hook back detent yoke, insert a suitable six-flute wrench into the 3/32 in. (2,4 mm) hole in the leadscrew (see Figure 2-31). The leadscrew may have to be turned to expose this hole, but do not lose the drive disk/ leadscrew relationship. Holding the leadscrew steady, tighten the drive disk screw to 4 lb in. (4,6 kg cm); use torque wrench, part 2597969, and screwdriver adapter, part 2597970.
   Note: Do not hold the disk while tightening.
8. Unhook yoke and move the carriage to track 207 or 107 (as appropriate) for check. If necessary, adjust sensor support bracket so that track-crossing hole is centered in the '7' slot.

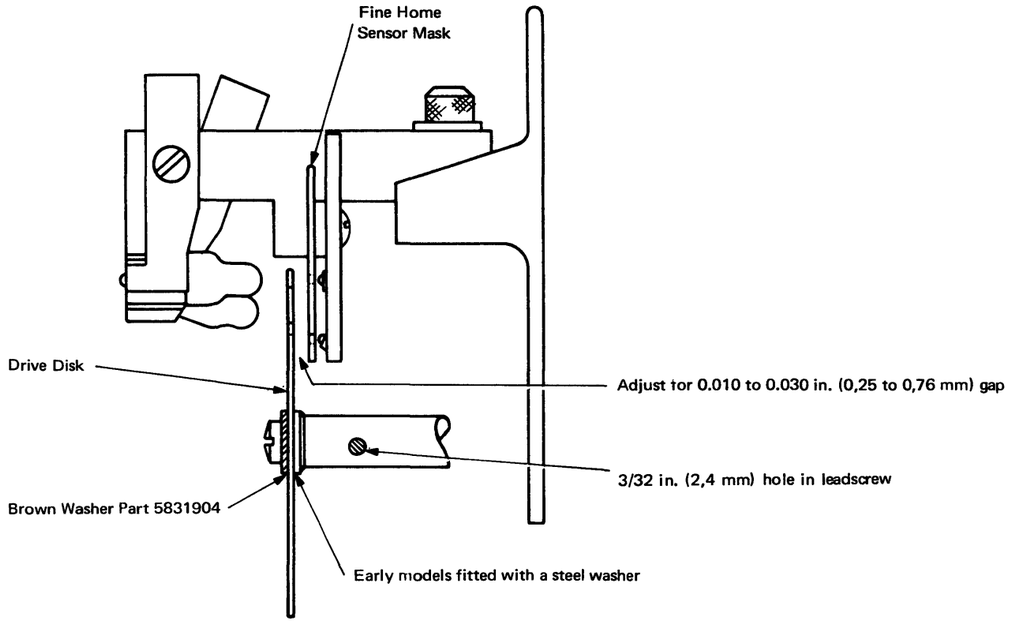


Figure 2-31. Drive Disk Adjustment [07554]

Note: If the track-crossing hole cannot be centered in the '7' slot, repeat the adjustment from step 4 onwards.

9. Replace drive tire (see 4.5.2.2) and detent cover.

4.5.4 Forward and Reverse Clutches

4.5.4.1 Service Check

1. Turn off power.
2. Remove detent cover.
3. Hook back yoke to disengage detent pawls.
4. The correct gap between each clutch pad and the drive tire is 0.015 in. (0,38 mm), including the 0.003 in. (0,08 mm) thickness of the drive disk (see Figure 2-30). A 0.012 in. (0,30 mm) feeler gage deflects the disk to touch the tire. Check that:
   a. When a 0.010 in. (0,25 mm) feeler gage is inserted in a similar way, the tire does not drive the disk.
   b. When 0.014 in. (0,36 mm) feeler gage is inserted, the tire drives the disk.
5. Refit detent cover.

4.5.4.2 Adjustment

Before the clutch adjustment is made, the leadscrew/ lower clutch/tire relationship must already be set. If both the layshaft and the lower clutch have been moved, the layshaft and the lower clutch have been moved,

To set up the upper (forward) clutch and reset the lower (reverse) clutch, proceed as follows:

1. Turn off power.
2. Remove detent cover.
3. Insert a 0.012 in. (0,31 mm) feeler gage between clutch pad and drive disk (see Figure 2-30).
4. Adjust clutch bracket eccentric (see Figure 2-28), with pivot screw and holding screw both loosened, until disk is deflected to touch the tire.
5. Tighten bracket and check clutch adjustment with 0.010 in. (0,25 mm) and 0.014 in. (0,36 mm) feeler gages.
6. Refit detent cover.

4.5.4.3 Removal

A coil failure or other faults on the clutch assembly requires a complete assembly change. Remove the clutch assembly as follows:

1. Turn off power.
2. Remove detent cover.
3. Remove clutch pivot and holding screws (see Figure 2-28), then withdraw clutch assembly, complete with eccentric.
   Note: The eccentric is a loose piece.

4. The clutch coil leads are wired in the loom. For replacement, cut leads where they enter loom at both ends and remove taper pins from edge connector EC2.

4.5.4.4 Replacement

1. Insert eccentric into support bracket. Carefully insert new clutch assembly or replace the original assembly without damaging the drive disk. Lightly tighten the screws.
2. Turning eccentric, position clutch pads clear of drive disk.
3. On a new assembly, dress the coil leads beside the loom to edge connector EC2. Tape on if necessary.
4. Adjust clutch pad/drive disk clearance, see 4.5.4.2.

4.5.5 Track-Crossing and Fine-Home Photocell Assembly

4.5.5.1 Adjustment

1. Turn off power.
2. Remove detent cover.
3. Detent the carriage at track 000, and check that the '0' slot in the drive disk is opposite the track-crossing photocell hole in the mask (Figure 2-32).
4. Viewing the hole through the slot, adjust the photocell assembly to center the hole, by adjusting support bracket in its slot.
5. Refit detent cover.

4.5.5.2 Removal and Replacement

Before removing photocell components, turn off power and remove the detent cover. On completion of replacement, refit the detent cover.

Lamps: To replace either lamp:

1. Push lamp out of its clip and cut lead to loom.
2. Replacement lamps have a long lead and pin for plug P5 (see ALD page ZA210). Put new lamp in clip, locating vee of clip on groove in body of lamp.
3. Run lead near loom to plug P5.
4. Push out old pin, cutting back to loom. Snap new pin into place.

Photocells: Any failure entails changing the assembly, part 2537349 (see Figure 2-32).

1. Remove support bracket and take off photocell and mask assembly.
2. To fit a new assembly, unsolder yellow and black connections. Resolder them on to new assembly, taking care not to burn printed circuit.
3. Refit support bracket, with sensor mask 0.010 to 0.030 in. (0,25 to 0,76 mm) from drive disk. Center the track-crossing hole in '0' slot of drive disk. (The relationship between fine-home and track crossing is fixed and, therefore, one adjustment sets up both photocells.)

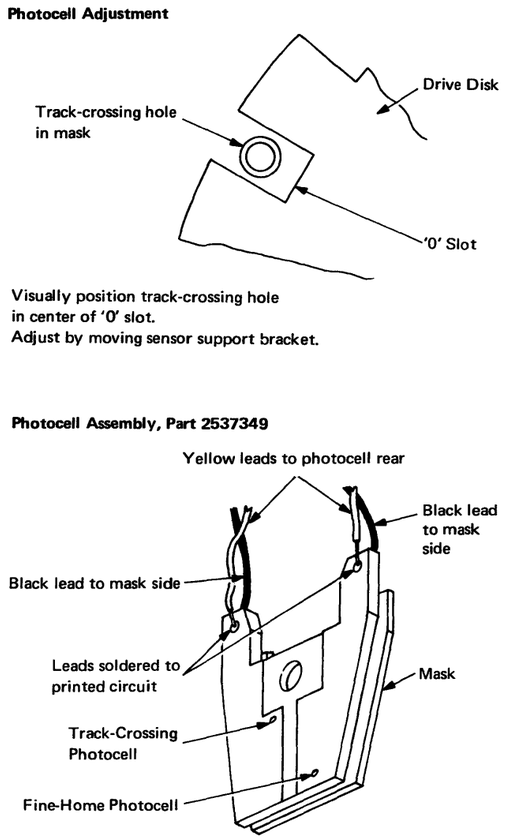


Figure 2-32. Photocell Assembly – Adjustment and Details [07555]

4.5.6 Carriage Photocell Assembly

4.5.6.1 Check

1. Remove top cover.
2. Connect a CE meter between pin Y-W1 C6B13 (see ALD page FN450) and a D08 ground pin.
3. Monitor '+ carriage PC lit'. With the carriage at track 006, the line should be active (+4V), and at track 004, it should be inactive (0V).
4. Refit top cover.

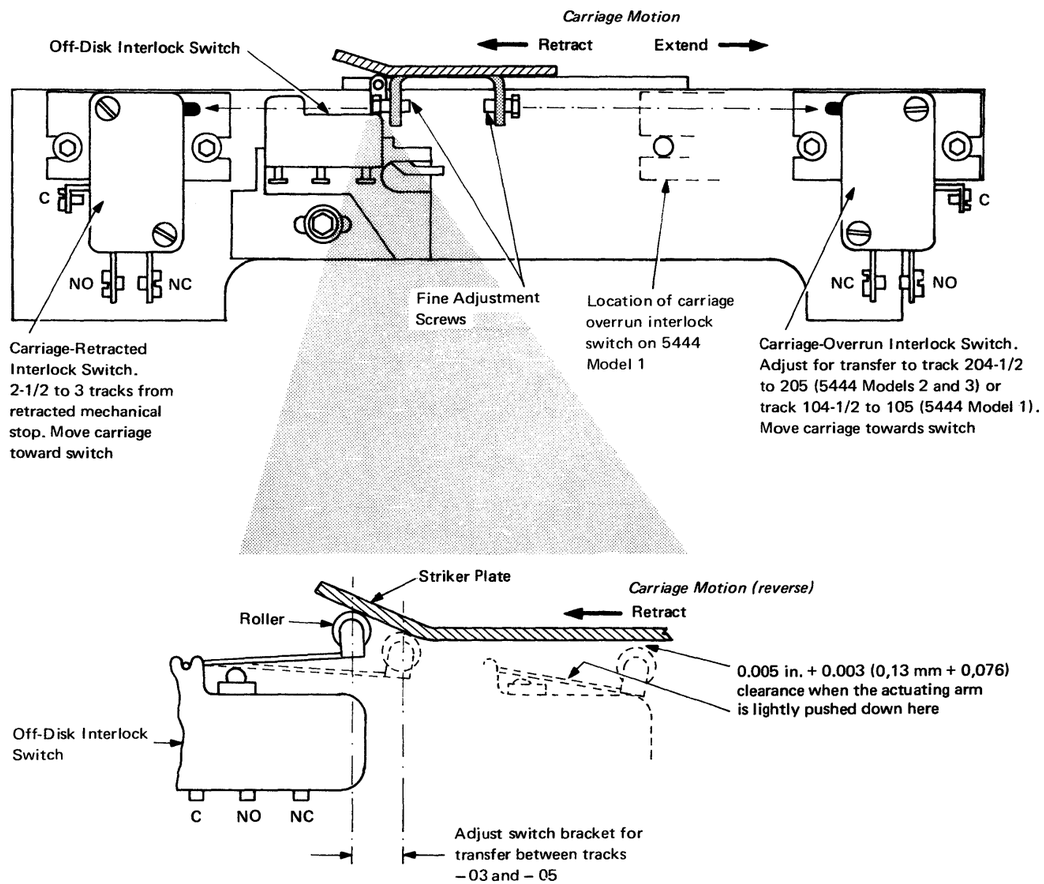


Figure 2-33. Carriage Interlock Switch Adjustment [07456]

4.5.6.2 Adjustment

1. Remove top cover.
2. Position carriage photocell assembly so that flag runs mid-way between photocell and lamp mask. Ensure that there is clearance on both sides of flag.
3. Detent carriage at track 005.
4. Monitor Y-W1 C6B13 (see 4.5.6.1) at track 005. Position the coarse home flag until '+ carriage PC lit' line just changes from +4V to 0V.
5. Tighten flag assembly and carry out checks at tracks 004 and 006 (see 4.5.6.1).
6. Refit top cover.

4.5.6.3 Removal and Replacement

1. Turn off power.
2. Remove top cover.
3. *Lamp:* Unclip lamp from holder and fit replacement lamp.
   Photocell: Unsolder photocell assembly leads, noting their position. Fit replacement assembly and resolder leads. Carry out adjustment procedure (see 4.5.6.2).
4. Refit top cover.

4.5.7 Carriage Interlock Switches

4.5.7.1 Adjustment of Carriage-Retracted and Carriage-Overrun Interlock Switches

Remove the top cover to gain access for the adjustments.

Carriage Retracted Interlock Switch: Adjust as follows:

1. Loosen six-flute socket screws on switch bracket, Figure 2-33.

2. Set the switch to transfer 2½ to 3 tracks before the retracted mechanical stop. Read the tracks off the drive disk.
3. Tighten socket screws.
4. Make fine adjustment with the fine adjustment screw.

Carriage-Overrun Interlock Switch: Adjust as follows:

1. Loosen six-flute socket screws on switch bracket (see Figure 2-33).
2. Set the switch to transfer 2½ to 3 tracks before the inner limit stop that is, at track 204½ to 205 (5444 Models 2 and 3) or track 104½ to 105 (Model 1). Read the tracks off the drive disk.
3. Tighten socket screws.
4. Make fine adjustment with the fine adjustment screw.

4.5.7.2 Off-Disk Interlock Switch Adjustment

1. Remove top cover.
2. Loosen six-flute socket screw holding bracket below the switch (see Figure 2-33).
3. Adjust the switch to transfer between tracks -03 and -05, that is, three to five tracks after track 000 when carriage is retracted. While making this adjustment, ensure that switch roller clears striker plate by 0.005 in. ± 0.003 (0,13 mm ± 0,08) when the switch actuating arm is lightly bottomed.
4. Refit top cover.

4.6 DETENT MECHANISM

The detent mechanism is composed of the detent wheel, voice coil assembly, and pawl bracket assemblies.

4.6.1 Detent Wheel

The detent wheel is integral with the leadscrew. Apart from cleaning and lubricating, no other action can be taken. Damage to the detent wheel involves a complete actuator change (see 4.4.1).

4.6.2 Voice Coil Assembly

The voice coil assembly, part 2537382, (Figure 2-34) is a factory-adjusted unit and individual parts cannot be changed. The magnet may be removed for cleaning. Locating dowels must not be disturbed.

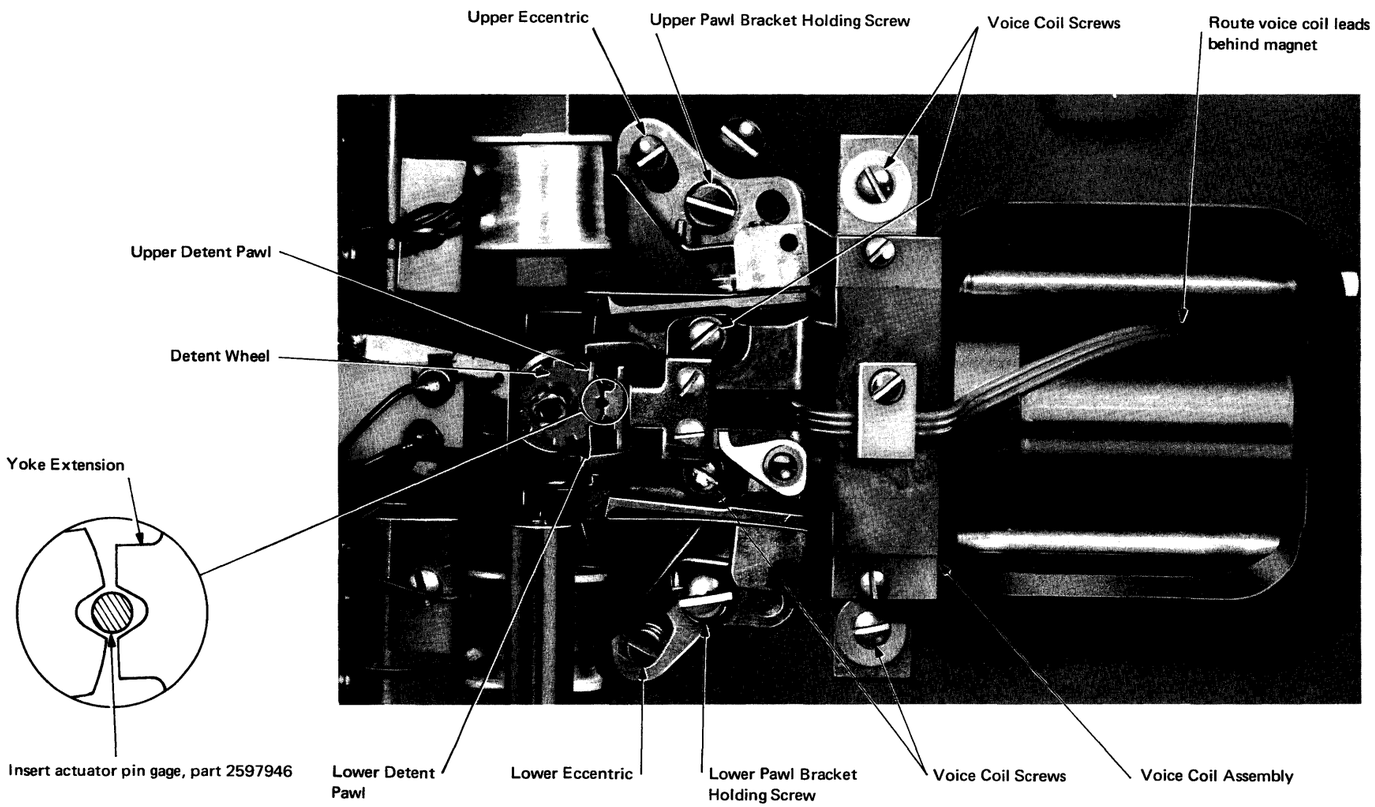


Figure 2-34. Voice Coil Assembly [07457]

4.6.2.1 Removal

1. Turn off power.
2. Remove detent cover, drive tire (see 4.5.2.2), and drive disk (see 4.5.3.2).
3. Note their route, then disconnect coil leads from edge connector EC2.
4. Remove the four voice coil screws (see Figure 2-34) and lift complete assembly from base casting.

4.6.2.2 Replacement and Adjustment

1. Position voice coil assembly (see Figure 2-34) on detent plate (see Figure 2-27). Ensure that locating dowels enter slots in plate. Insert and hand-tighten screws, leaving assembly free to move.
2. To refit original assembly, do not disturb pawl brackets. To fit a new assembly or when the detent pawls require adjustment, loosen pawl bracket holding screws.
3. Insert actuator pin gage, part 2597946, in between the crests of the detent wheel (see detail in Figure 2-34). Slide voice coil assembly forward until V-shaped extension on yoke grips the gage with no clearance: *do not use force.* Tighten coil holding screws.
4. Connect voice coil leads, routing them behind voice coil assembly as shown in the figure.
5. Leaving gage in place, adjust lower pawl bracket eccentric so that lower detent pawl rides on crest of detent wheel tooth. Continue turning until detent pawl just drops down flank of tooth. Tighten lower pawl bracket holding screw.
6. Withdraw actuator pin gage. Turn upper pawl bracket eccentric to bring upper detent pawl on to crest of detent wheel tooth, then continue turning until the detent pawl drops down tooth flank. Keep lower pawl against its tooth flank but do not deflect the pivot spring. Tighten upper pawl bracket holding screw.
7. Rotate detent wheel, checking remainder of the teeth to ensure that both pawls drop into roots of the detent wheel teeth. If one tooth is found that will not allow this, slightly re-adjust upper bracket.
8. Refit drive disk (see 4.5.3.3), drive tire (see 4.5.2.2), and detent cover.

4.6.3 Pawl Bracket Assemblies

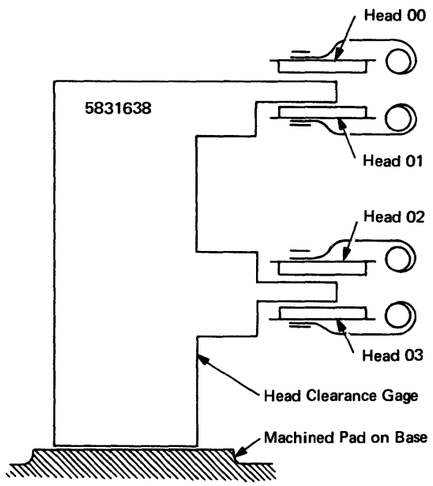
Only the detent pawls and pawl return springs in the pawl bracket assemblies are field replaceable. The remainder of the pawl bracket assembly must be replaced completely.

4.6.3.1 Removal and Replacement

1. Turn off power.
2. Remove detent cover, drive tire (see 4.5.2.2), drive disk (see 4.5.3.2), and voice coil assembly (see 4.6.2.1).
   Note: Do not put the voice coil on a dirty surface where the magnet can attract magnetic particles.
3. Remove pawl bracket holding screw (see Figure 2-34). The eccentric adjuster is a loose piece that is secured by the bracket; do not drop it, therefore, as bracket is withdrawn.
4. If only detent pawls or return springs are to be changed, lubricate new parts with Molykote 'G' at spring loops and pivot point, and on yoke contacting face. After cleaning original parts lubricate in the same way.
5. Mount pawl brackets on pivot stud of voice coil assembly. The upper bracket with offset pivot fits nearest the voice coil. Put eccentrics in recesses of detent plate.
6. Position voice coil assembly, with brackets, on to detent plate. Locate dowels in the detent plate and locate eccentrics in bracket slots. Fit and hand-tighten screws for voice coil assembly and pawl brackets.
7. Adjust voice coil assembly (see 4.6.2.2).

4.6.3.2 Voice Coil Magnet Cleaning

Pieces of attracted debris can be removed by picking them off the voice coil magnet with adhesive tape. Do not put the voice coil on a dirty surface where the magnet can attract pieces of magnetic debris.



As the heads move forward they must clear the gage

Figure 2-35. R/W Head Clearance Check [07558]

4.7 R/W HEAD ARM ASSEMBLY

4.7.1 Checks, Adjustments, and Removals

4.7.1.1 Height Check

1. Turn off power.
2. Remove top cover.
3. Check that carriage is fully retracted and heads are unloaded.
4. Remove disk cartridge.
5. Place head clearance gage, part 5831638, on machined pad at the disk side of the cable clamp pillar (Figure 2-35). Jaws of tool should be behind the heads.
6. Carefully retract carriage and check that the heads clear the jaws of the tool. If a head does not clear the jaws, change the head arm (see 4.7.1.4 and 4.7.1.5) and recheck. If the new head does not clear the jaws, check adjustment of head-load spring shaft (see 4.8.4.1).
7. Remove tool, then refit disk cartridge and top cover.

4.7.1.2 Head Damage

The routine inspection for damage to R/W heads is described in 3.2.2. A faulty head can give read/write errors or can cause damage to a disk; typical symptoms of faulty heads are:

1. A rapid accumulation of oxide on a particular head.
2. Regularly spaced radial, circular, or spiral scratches on the disk surface.
3. Tinkling noises, caused by the head bouncing on the disk.

In all cases, the faulty head must be changed (see Figure 2-4). On replacement, align the new head (see 4.7.1.3) and clean the disk.

4.7.1.3 Head Alignment

Alignment of Heads 00 and 01: The two upper R/W heads need to be aligned so that they can accept any disk cartridge. The two lower R/W heads keep a constant relationship with the fixed disk.

1. Turn off power.
2. Remove disk cartridge.
3. Install CE cartridge, part 2537301 (see 2.3.3.2).
4. Turn on power.
5. Remove the top cover and observe that R/W heads are loaded to track 000.
6. Operate the switches on the CE panel to move heads to track 073 (see 2.2).
7. Set CE mode-select switch to HD0.
8. Set the Tektronix 453 oscilloscope (using X1 probe) as follows:

Channel 1: Y-W1 K6J12 (linear read signal 1; see ALD page FN260).
Channel 2: Y-W1 K6J10 (linear read signal 2; see ALD page FN260).
Trigger Positive: Y-W1 D6G03 (index pulse; see ALD page FN445).
Mode: Add.
Channel 1: Normal. 50 millivolts per division.
Channel 2: Inverted. 50 millivolts per division.
Time/division: 5 milliseconds per division.

Note: Before commencing alignment, run the CE cartridge for 15 minutes to allow it to reach the temperature of the 5444.

9. Slacken clamp screw of the upper head arms. Turn back, *by one-quarter of a turn,* the adjustment screws of the two upper head arms. (Figure 2-36).
10. Push R/W heads 00 and 01 back to the adjustment screws and tighten clamp screw to 4 lb in. (4,6 kg cm) with torque wrench, part 2597969, and 6-flute adapter, part 2597971.
11. Screw in on the adjustment screw of head arm 00; as the R/W head approaches track 073, the oscilloscope display loops appear (see Figure 2-36). Continue to screw in carefully until the loops are similar in size, 3.8 to 4.2 divisions in length. Use the horizontal sweep control to place the two loops across eight divisions.
    Note: The head arm adjustment screw only pushes the arm forward. If track 073 is overshot, return to step 9.
12. Set CE mode-select switch to HD1. Screw in on the adjustment screw of head arm 01 and set the equal length loops as in step 11.
13. Remove CE cartridge.

Alignment of Heads 02 and 03: If the data on the fixed disk has to be retained, refer to the error recovery procedure in 1.5.
Align heads 02 and 03 as follows:

1. Slacken clamp screw of the lower head arms. *Fully* turn back the adjustment screws of the two lower head arms.
2. Insert a 0.025 in. (0,64 mm) feeler gage between rear of arms and carriage casting (see Figure 2-36), then tighten the clamp screw to 4 lb in. (4,6 kg cm) with torque wrench, part 2597969, and 6-flute adapter, part 2597971.
3. After tightening, turn forward head arm adjustment screws to just touch the head arms. Check that gap is still 0.025 in. ± 0.003 (0,64 mm ± 0,08).
4. Refit top cover.

4.7.1.4 Removal

If R/W heads 02 and 03 are to be removed and the data on the fixed disk to be retained, transfer the data to a disk cartridge before head removal. Refer to 1.5.

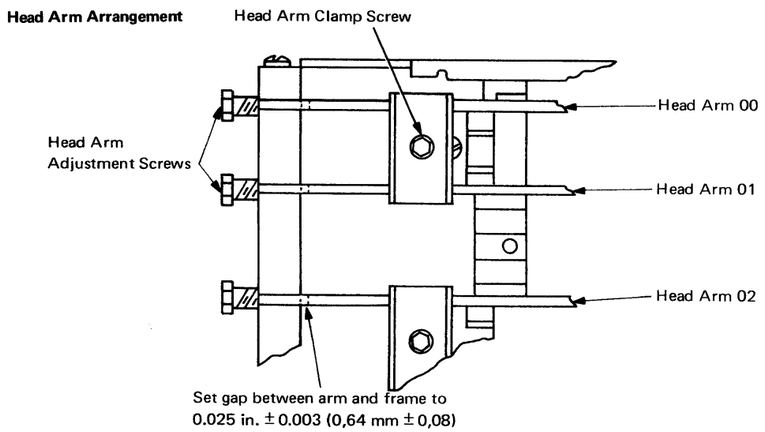


Figure 2-36. Head Arm Alignment, using CE Cartridge Track 073 [07559]

CAUTION
In the following steps, do not touch the face of the R/W head. Do not touch the disk with the head arm.

1. Turn off power.
2. Remove disk cartridge and top cover.
3. Remove clamp and unplug head connector at gate Z (Figure 2-37).
4. Release head cable shield from clamp pillar and from carriage cable clamp.
5. Take off appropriate head arm clamp (see Figure 2-36).
6. Take out head sideways from carriage, holding by the head support arm.

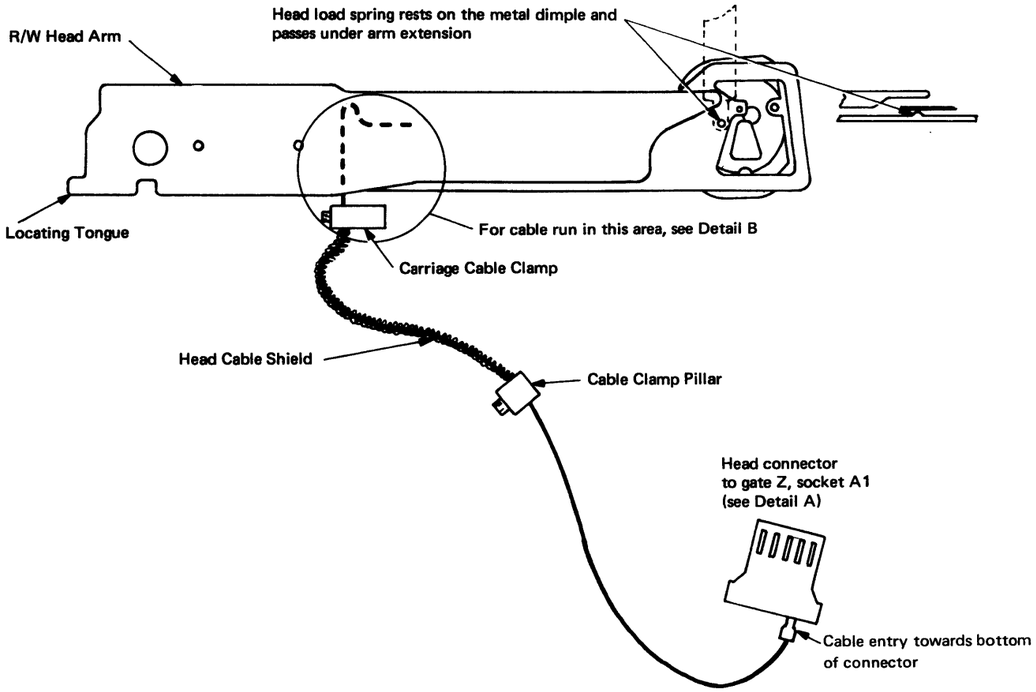
4.7.1.5 Replacement

CAUTION
In the following steps, do not touch the face of the R/W head. Do not touch the disk with the head arm.

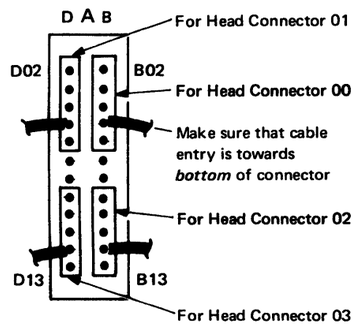
1. Route the cable in the new R/W head arm as shown in Figure 2-38. Open the leaf spring *not more than 1/5 in. (5 mm)* to insert cable.
2. Slide head into carriage from the side. Insert locating tongue (see Figure 2-37) of arm in a slot near head arm adjustment screw.
    Note: Make sure that the head-load springs are correctly located on the metal dimple and pass under the arm extension as shown in Figure 2-37.
3. Loosely fit head arm clamp. Secure ends of head cable shield in the carriage clamp and clamp pillar (see Figure 2-37).
4. Plug head connector into socket A1 of gate Z (see Figure 2-37), then check that the head cables do not touch the disk at any carriage position. Refit the head plug clamp at gate Z.
5. Carry out the height check and alignment procedures (see 4.7.1.1 and 4.7.1.3).
6. Install disk cartridge and refit top cover.

4.7.2 Cleaning R/W Heads

For the methods of cleaning R/W heads, see 3.2.2.2 and 3.2.2.3.



Detail A. Gate Z, Socket A1



Detail B. Cable Runs at R/W Head Arms

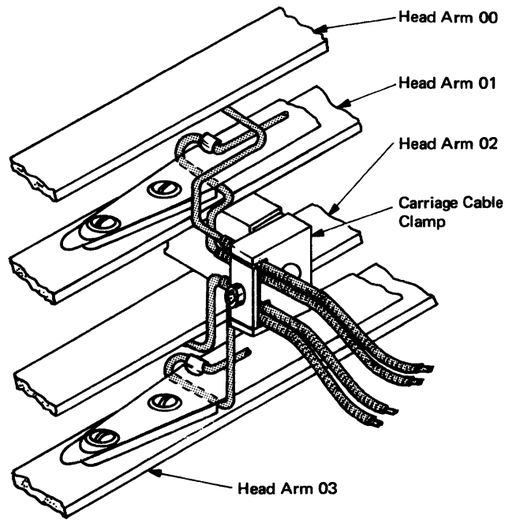


Figure 2-37. Cable Connections for R/W Head Arm [07560]

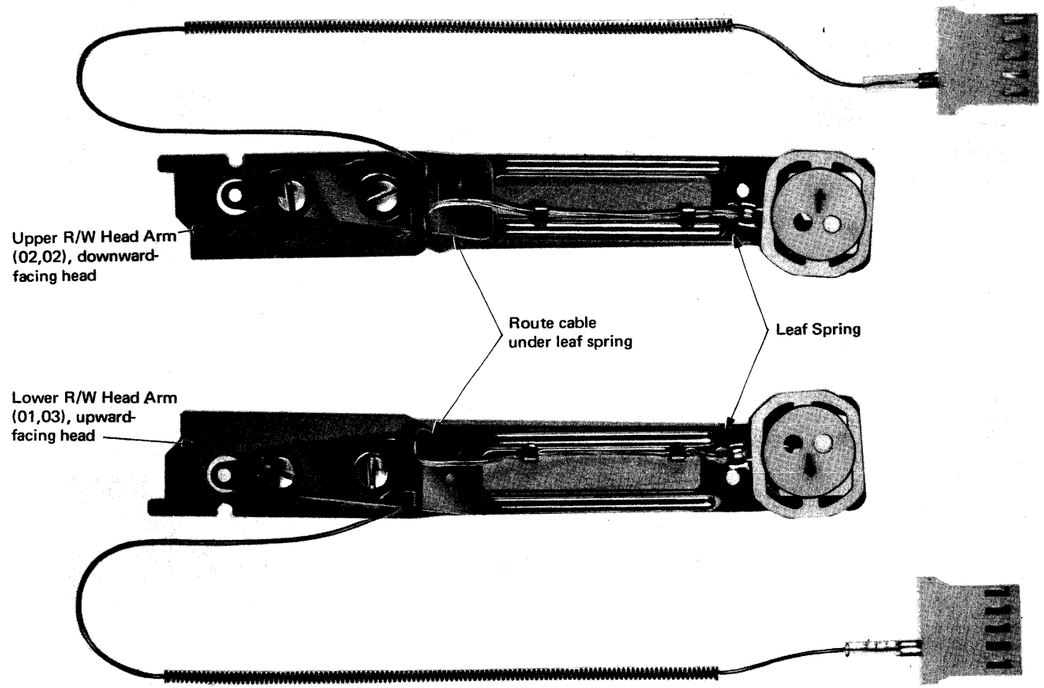


Figure 2-38. Cable Routing in R/W Head Arm [07575]

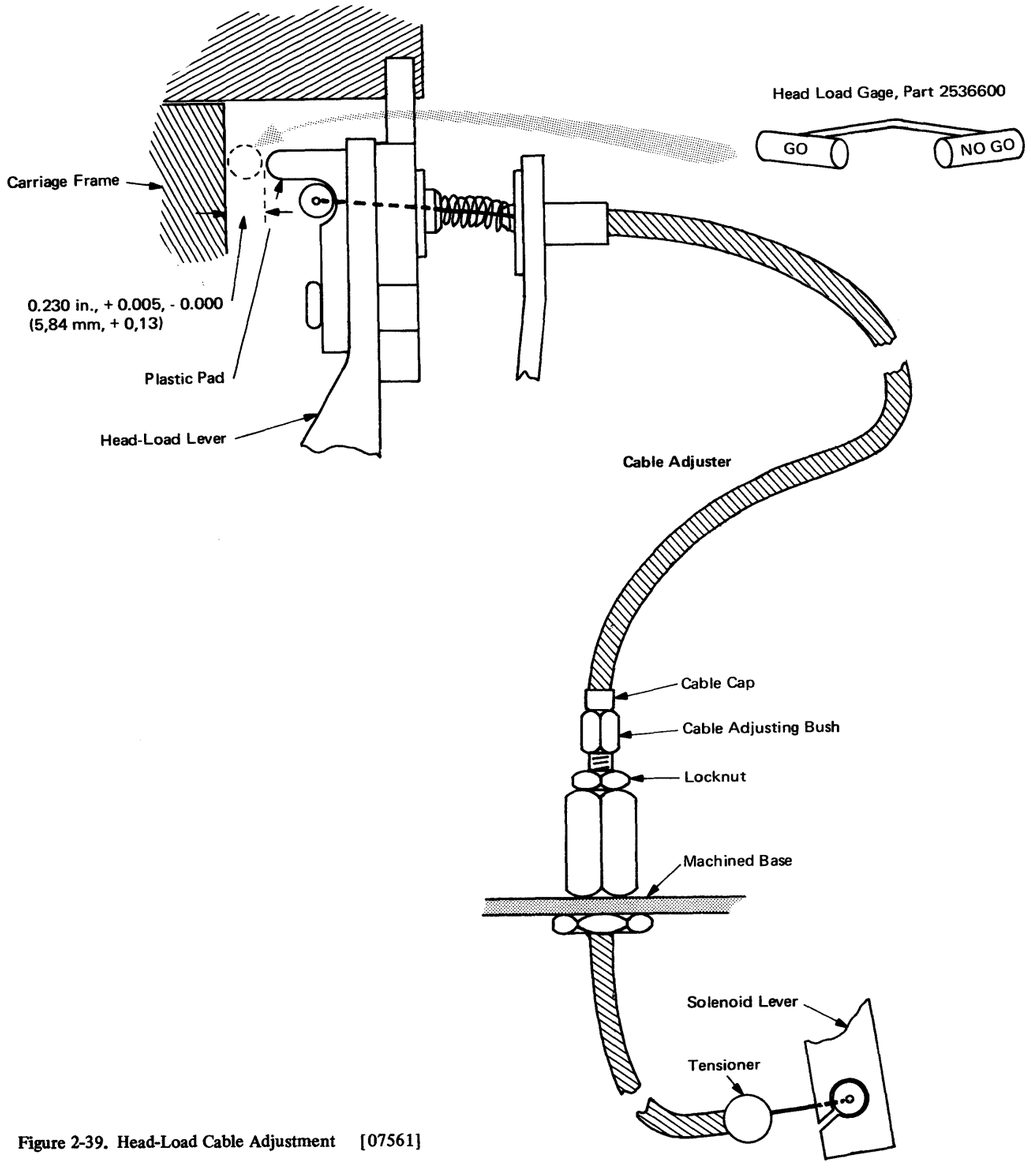


Figure 2-39. Head-Load Cable Adjustment [07561]

4.8 HEAD-LOAD MECHANISM

4.8.1 Head-Load Cable

4.8.1.1 Adjustment

1. Turn off power and remove top cover.
2. Check that carriage is fully retracted.
3. Remove cover from head-load assembly.
4. Insert a lint-free tissue between each pair of R/W heads.
5. Slacken cable adjuster locknut (Figure 2-39). Ensure that cable cap is seated in cable adjusting bush.

CAUTION
The action in the following step brings the heads together and must, therefore, be done with care and not repeated more than necessary.

6. Gently push in plunger of head-load solenoid until it bottoms.
7. The gap between the plastic pad on the head-load lever and the carriage frame should be 0.230 in., +0.005, -0.000 (5,84 mm +0,13), see Figure 2-39. Check by inserting the 'GO' arm of head-load gage, part 2536600, between head adjusting screw and trip arm.
8. Adjust gap with the cable adjusting bush and check that 'NO GO' arm cannot be inserted. After adjustment, tighten adjuster locknut.
9. Remove tissues from R/W heads.
10. Refit cover to head-load assembly. Refit top cover.

4.8.1.2 Removal and Replacement

1. Turn off power.
2. Remove top cover and check that carriage is fully retracted.
3. Remove cover from head-load assembly.
4. Insert a lint-free tissue between each pair of R/W heads.
5. Slacken cable adjuster locknut (see Figure 2-39). Screw in the cable adjusting bush. Slip outer cable from tensioner and lift cable nipple out of solenoid lever. Take care not to bring the heads forcibly together.
6. Disconnect other end of cable from head-load lever.
7. Unscrew complete adjuster and remove cable assembly.
8. Fit cable assembly in reverse order to removal.
9. Carry out the adjustment (see 4.8.1.1). Ensure that cable cap seats correctly in cable adjusting bush, or, otherwise, partial head loading will result.
10. Remove tissues from R/W heads.
11. Refit cover to head-load assembly. Refit top cover.

4.8.2 Head-Load Solenoid and Lever

4.8.2.1 Adjustment

1. Turn off power.
2. Remove top cover and check that carriage is fully retracted.
3. Remove cover from head-load assembly.
4. Insert a lint-free tissue between each pair of R/W heads.

5. Adjust lever stop bracket (Figure 2-40) by its securing screws to obtain a clearance of 0.015 in. ± 0.010 (0,38 mm ± 0,25) between bracket and lever with no slack on the head-load cable. Press *lightly* on the solenoid plunger to take up cable slack.
6. Remove tissues from R/W heads.
7. Refit top cover to head-load assembly. Refit top cover.

4.8.2.2 Removal and Replacement

1. Turn off power.
2. Remove top cover and cover from head-load assembly.
3. Disconnect head-load solenoid cable.
4. Remove circlip from pivot pin and push out pin (see Figure 2-40). Make sure that pin is not dropped.
5. Remove solenoid securing screws (2) and withdraw unit.
6. Install solenoid in reverse sequence to removal.
7. Check adjustment (see 4.8.2.1).

4.8.3 Solenoid Switches

4.8.3.1 Service Check

1. Turn off power.
2. Remove top cover and cover from head-load assembly.
3. Check that carriage is fully retracted.
4. Insert lint-free tissue between each pair of R/W heads.
5. Check that both solenoid switches (see Figure 2-40) transfer when solenoid plunger is 1/10 in. (2,5 mm) from the bottomed position.
6. Adjust as necessary (see 4.8.3.2).
7. Remove tissues from R/W heads.
8. Refit covers.

4.8.3.2 Adjustment

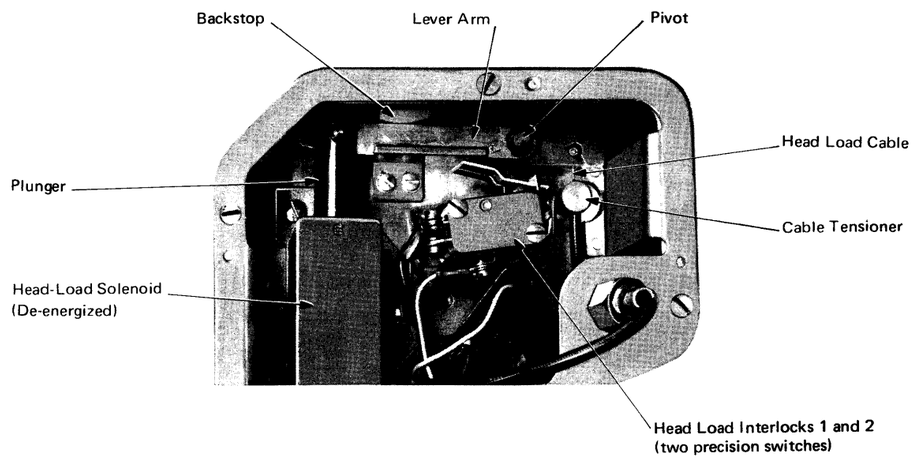
1. Turn off power.
2. Remove top cover.
3. Set carriage to fully retracted position.
4. Remove head-load assembly cover plate. Protect the heads.
5. Insert lint-free tissue between each pair of R/W heads.

   CAUTION
   The action in the following steps brings the heads together and must, therefore, be done gently and not repeated more than necessary.

6. Slowly depress solenoid plunger until it bottoms (see Figure 2-40).
7. Mark bottom position of plunger with a pencil or piece of adhesive tape.
8. Allow the plunger out 1/10 in. (2,5 mm).
9. Loosen switch mounting bracket screw in its slot and swing the assembly until both switches transfer with the solenoid plunger still 1/10 in. (2,5 mm) from the bottom position.
10. Let the plunger gently come fully out, then depress it again to check the operating position.
11. Remove adhesive tape.
12. Remove tissues from R/W heads.
13. Refit cover to head-load assembly.
14. Refit top cover.

4.8.3.3 Removal and Replacement

1. Turn off power.
2. Remove top cover and head-load assembly cover.
3. Remove screw securing switch mounting plate (see Figure 2-40).
4. Note lead connections and disconnect leads from edge connector EC4 and from switches.
5. Lift mounting plate, together with both switches, from base.
6. Remove faulty switch from mounting plate.
7. Assemble switches in reverse sequence to removal.
8. Adjust switches (see 4.8.3.2).
9. Remove tissues from R/W heads.
10. Refit cover to head-load assembly.
11. Refit top cover.



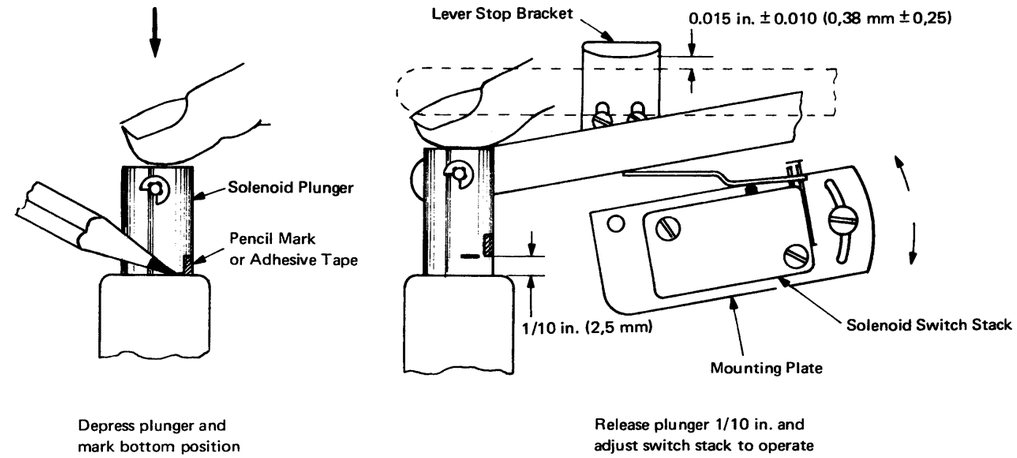


Figure 2-40. Head-Load Solenoid Switch Adjustment [07576]

4.8.4 Head-Load Spring Shafts

4.8.4.1 Adjustment

1. Attempt to recover data from the fixed disk before removing heads (see 1.5).
2. Turn off power and remove disk cartridge.
3. Remove top cover and detent cover.
4. Hook back detent yoke, to disengage detent pawls.
5. Ensure that carriage is fully retracted then remove head arm assemblies (see 4.7.1.4).
6. Remove cable clamp pillar (Figure 2-41). Locate disk-clearance and head-load spring gage, part 5831639, on the machined pad and secure with captive screw.
7. Remove knock-off trip (Figure 2-42).
8. Remove cover over power transistors (see Figure 2-46).
9. Take out head-load cable from cable guide and from head-load lever.
10. Set links in the sequence 02, 03, 01, and 00. (02 is the master shaft carrying the head-load lever.) Refer to Figure 2-41.

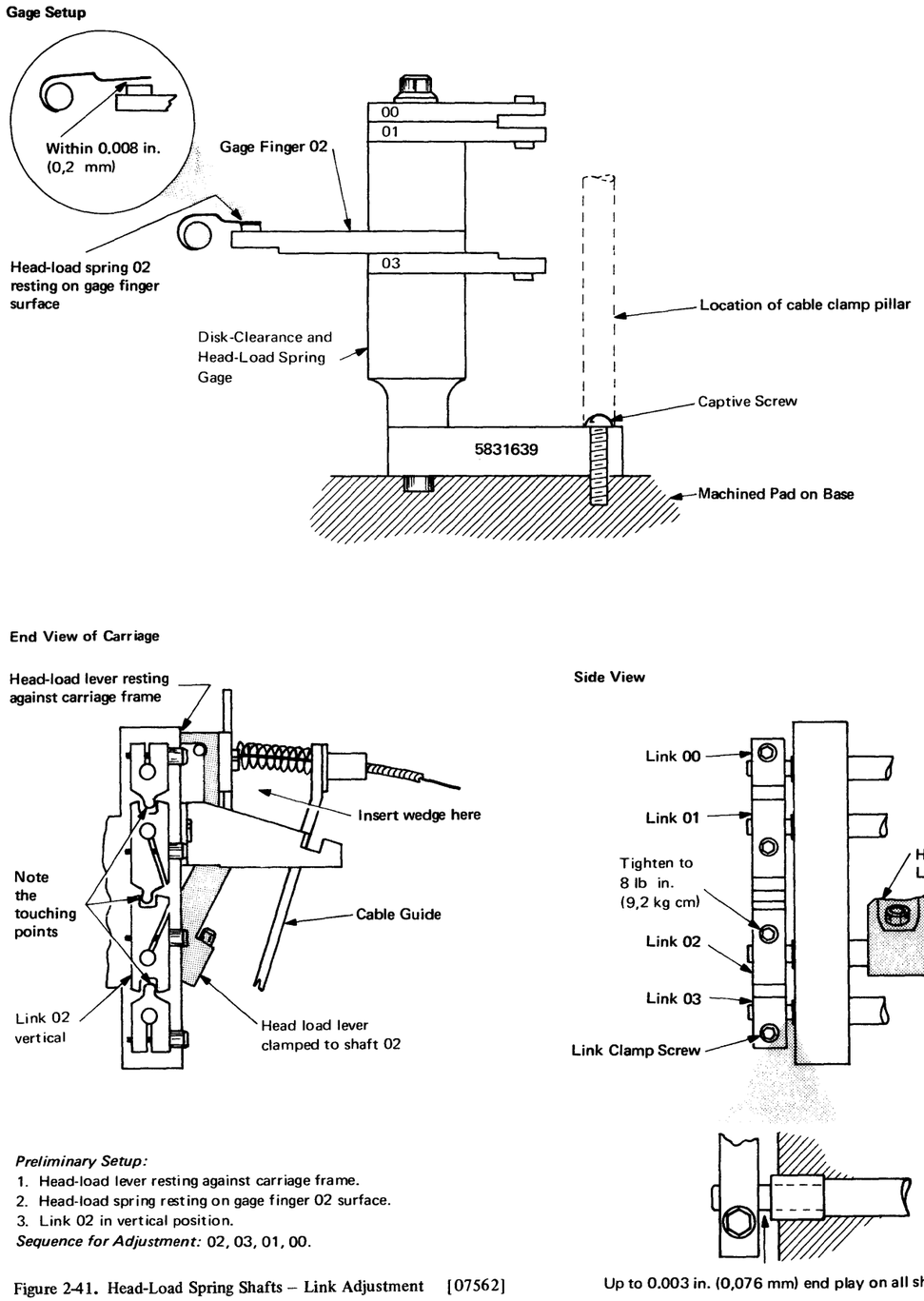
CAUTION

In the following steps, make sure that the head-load springs are clear of the fixed disk surface before moving the carriage.

Note: Each link is dependent upon the other and, therefore, all links must be checked if one is adjusted.

a. With head-load lever touching side of carriage frame and central in the cast recess, head-load spring 02 should just touch the 02 gage surface. Loosen clamp screw on head-load lever to obtain this condition, then tighten screw and check that head-load spring is within 0.008 in. (0,2 mm) of the 02 gage surface.
b. Insert a folded-card wedge between cable guide and head-load lever. Keep the lever touching the carriage frame and push the carriage forward to track 100.
c. With head-load lever still touching carriage frame, loosen clamp screw of link 02 and set this link vertical. Tighten screw to 8 lb in. (9,2 kg cm) with torque wrench, part 2598187. Check that end play of shaft 02 does not exceed 0.003 in. (0,076 mm).
d. Swing gage arm 02 clear and position arm 03.
e. Loosen clamp screw of link 03 and move carriage back until load spring of head 03 rests flat on the 03 gage surface. Adjust link 03 to touch link 02 then tighten clamp screw of link 03.
f. Move carriage out to track 100 and tighten clamp screw to 8 lb in. with torque wrench, part 2598187.
g. Retract carriage. Check that head-load spring 03 is within 0.008 in. (0,2 mm) of the 03 gage surface and that end play of shaft 03 does not exceed 0.003 in.
h. Repeat steps d through g, but for link 01.
Note: Adjust all head-load springs whether blank arms are fitted in the lower positions or not.
i. Repeat steps d through g, but for link 00. Make sure that the touching point with link 01 is correct (see Figure 2-41).

11. Remove gage and re-install head-load cable.
12. Refit power transistors cover.
13. Check setting of head knock-off trip (see 4.8.5).
14. Refit head arm assemblies (see 4.7.1.5).
15. Release detent yoke, to engage detent pawls.
16. Refit detent cover and top cover.
17. Install disk cartridge.
18. Re-initialize fixed disk.



Preliminary Setup:
1. Head-load lever resting against carriage frame.
2. Head-load spring resting on gage finger 02 surface.
3. Link 02 in vertical position.

Sequence for Adjustment: 02, 03, 01, 00.

Figure 2-41. Head-Load Spring Shafts – Link Adjustment [07562]

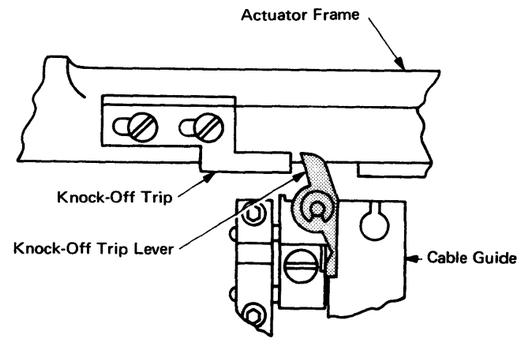


Figure 2-42. Knock-Off Trip and Trip Lever [07563]

4.8.4.2 Removal

1. Turn off power.
2. Remove top cover.
3. Remove disk cartridge.
4. Remove detent cover and hook back detent yoke to disengage detent pawls.
5. Remove the appropriate R/W head arm (see 4.7.1.4) as follows:
   a. For head-load spring shaft 00 or 01, remove head arms 00 and 01.
   b. For shaft 02 or 03, remove actuator assembly (see 4.4.1.1) to prevent damage to the fixed disk. In addition, for shaft 02, remove *all* head arms; for shaft 03, remove head arms 02 and 03.
6. Loosen link clamp screw and take off link. (Note which link belongs to which shaft.)
7. Because shaft 02 carries the head-load lever, loosen the lever clamp screw and remove the lever.
8. Holding carriage steady, pull out shaft towards center of disk.

4.8.4.3 Replacement

1. Smear a thin film of IBM no. 20 grease on bearing ends of head-load spring shaft.
2. Push in shaft until its shoulder bears on bush. When shaft is fully home, wipe away excess grease with a lint-free tissue.
3. On shaft 02, install head-load lever and secure with the clamp screw.
4. Adjust head knock-off trip (see 4.8.5).
5. Fit the link and commence adjustment (see 4.8.4.1). *Note:* On all models, the head-load springs must be checked with the head-load spring gage, even if blank arms are fitted in the lower positions.

4.8.5 Knock-Off Trip Adjustment

Whenever the head-load lever is released from the master 02 head-load spring shaft, readjust the knock-off trip.

1. After fitting and clamping the head-load lever, check that the support spring and cable guide are vertical to the carriage casting (Figure 2-43), to allow the head-load cable to run straight between the head-load lever and the cable guide. Ensure that the ear on the cable guide engages fully in the support spring.
2. With the carriage positioned at track 000, the trip lever should have 0.040 in. ± 0.005 (1,02 mm ± 0,127) clearance to the trip. Adjust the trip by loosening its screws to obtain this clearance.

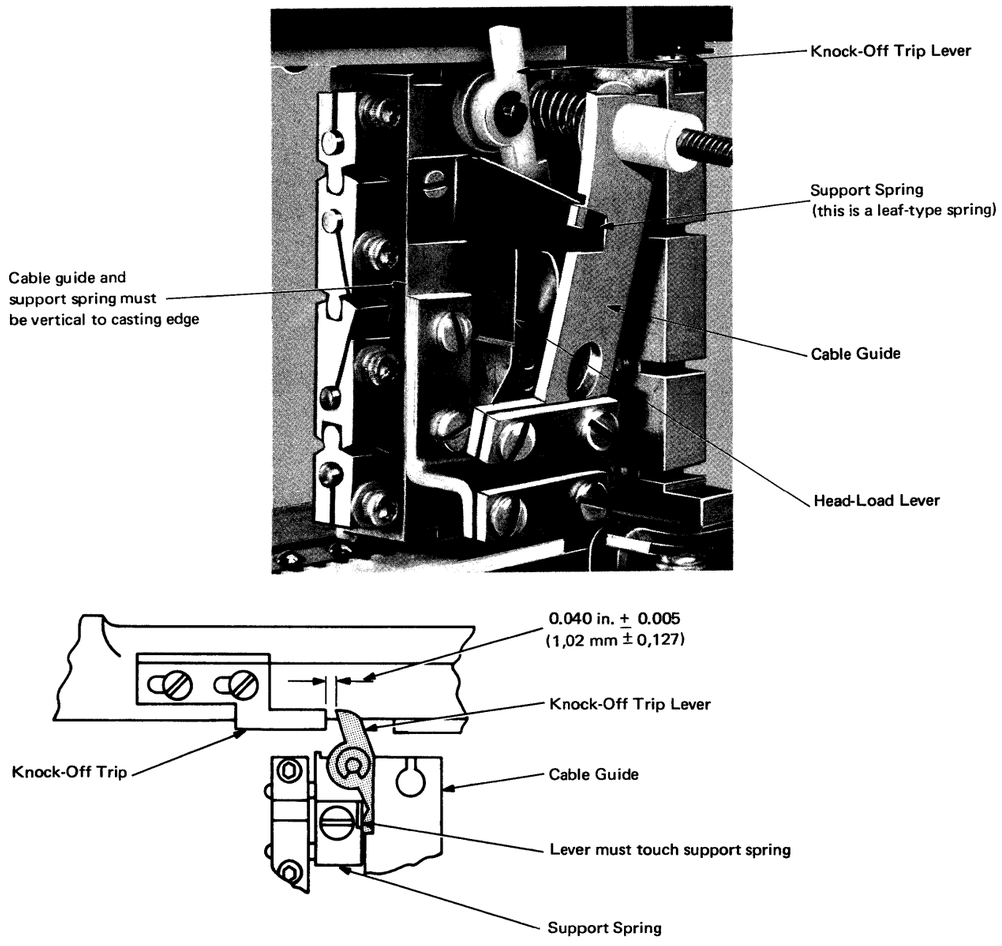


Figure 2-43. Knock-Off Trip Adjustment [07577]

4.9 AUXILIARY ELECTRONICS

The auxiliary electronics are mounted on six solid logic technology (SLT) cards that are plugged into one half of the Y logic board. The data channel and tape cable entries occupy the remaining sockets in the board.

CAUTION
Turn off power before removing or replacing SLT cards.

4.9.1 Fault Finding

The method of fault finding is based on the MAP package that is contained in the using system. The basic method of fault correction in the 5444 is by card replacement.

4.9.2 Index Transducer Checks

Output waveforms of the upper and lower index transducers are similar. Measure the waveforms and index pulses (Figure 2-44). If the negative peak value for a transducer is below that shown:

1. Check setting of transducer and readjust as necessary (see 4.2.3.1 or 4.2.4.1).
2. Re-measure waveform and index pulse.
3. If negative peak value is still incorrect, change transducer (see 4.2.3.2 or 4.2.4.2).
   If the positive-going edge of the index pulse does not coincide with the waveform zero crossover point, change the index amplifier card (see ALD page FN445).

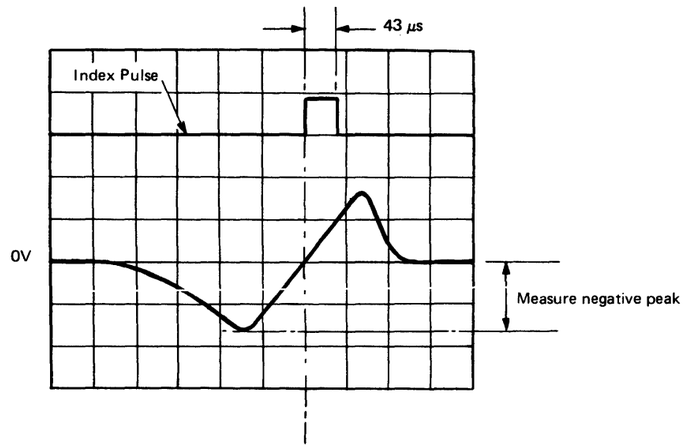
4.9.3 Detent Voice Coil Control

Voice coil control circuits are on cards Y-W1 E6 and Y-W1 F6. Driver power transistors Q3 through Q6 are located on the casting behind the voice coil. Typical waveforms are shown in Figure 2-45.

CAUTION
Do not disturb the pick SS potentiometer on the voice coil control card. This potentiometer is preset and sealed at the factory.

Section 2. Features

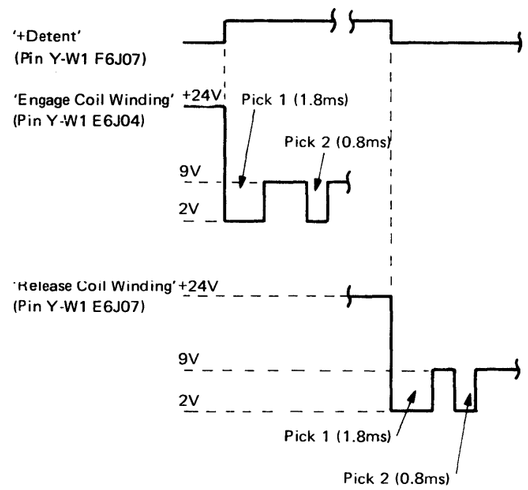
No features are fitted to the 5444.



Index Transducer	Output Waveform		Index Pulse (See Note)	
	Measure at	Negative Peak Value	Measure at	Width
Upper	Pin Y-W1 D6D13	More than 1.3V	Pin Y-W1 D6B03	Approx. 43 μs
Lower	Pin Y-W1 D6J07	More than 1.66V	Pin Y-W1 D6B02	Approx. 43 μs

Note: Positive-going edge of index pulse must coincide with zero crossover point of waveform.

Figure 2-44. Index Transducer Waveform Check [07564]



Note: For details, refer to ALD page FN495

Figure 2-45. Detent Voice Coil Waveforms [07565]

Chapter 5. Power Supplies

Section 1. Basic Unit

5.1 GENERAL

All power supplies to the 5444 are fed from the using system to terminal block TB1 in the ac box, and TB3 in the dc box (see Figure 2-47). Supplies at TB1 and TB3 are as follows:

TB3. DC Input in DC Box
(ALD page ZA250)

1. +6V
2. -4V
3. -30V
4. +24V Regulator
5,6. Logic ground
7. +24V Driver
8. 24V Driver common
9. +24V File start
10. Jumper points

TB1. AC Input in AC Box
(ALD page ZA200)

1. Line voltage
3. Line neutral

AC Box Ground to TB3. (ALD page ZA200)

Brush motor supply

DANGER
Power to the 5444 may not be automatically disconnected when the enclosure has been opened and the cartridge removed. Unless the complete system is powered down, some terminal blocks remain live.

5.2 AC POWER

The ac power is as follows:
Average ac current: 1.0 ampere maximum.
Peak ac current: 3.5 amperes maximum.

5.3 PROTECTIVE DEVICES

No fuses or manual cutouts are provided in the 5444. A thermal cutout operates on drive motor overtemperature condition and automatically resets when the motor cools down.

5.4 18V REGULATORS

Two 18V regulated supplies, positive and negative, are produced by a voltage regulator card sharing level converters. The supplies are:
+18V dc, 600 milliamperes maximum (Transistor Q1)
-18V dc, 300 milliamperes maximum (Transistor Q2)
The metering points are:
+18V: Y-W1 N6D03.
Ground: Any D08.
-18V: Y-W1 N6B13.

5.4.1 Checking

No servicing or adjustment is possible on the 18V regulator other than checking that +24V and -30V inputs are present. The output should be 18V ± 0.5V. If a regulator card appears defective, change the card or, if the fault persists, check the transistors Q1 (+18V) and Q2 (-18V), which are mounted on the machine front casting.

Section 2. Features

The 5444 has no features.

6.1 PHYSICAL COMPONENTS

Figures 2-46, 2-47, and 2-48 show the location of physical components in the 5444.

6.2 ELECTRICAL SYSTEM COMPONENTS

ALD page OA000 provides an index of other ALD pages that show the locations of electrical system components in the 5444.

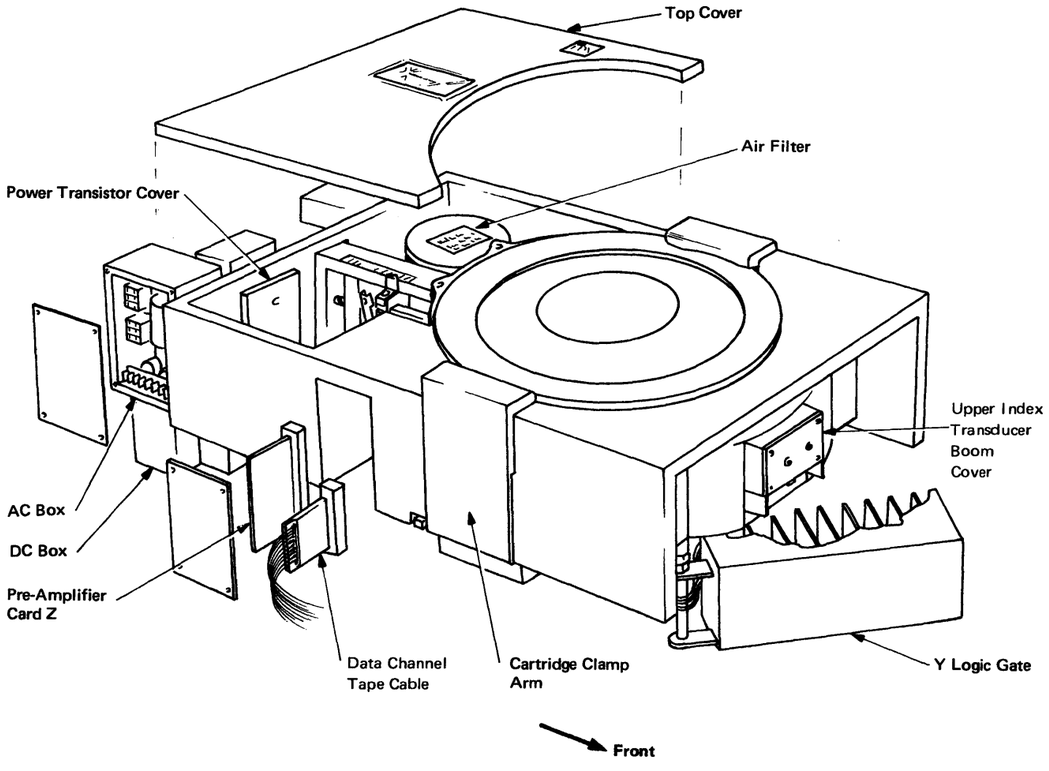


Figure 2-46. Front Top View of 5444 – Locations [07566]

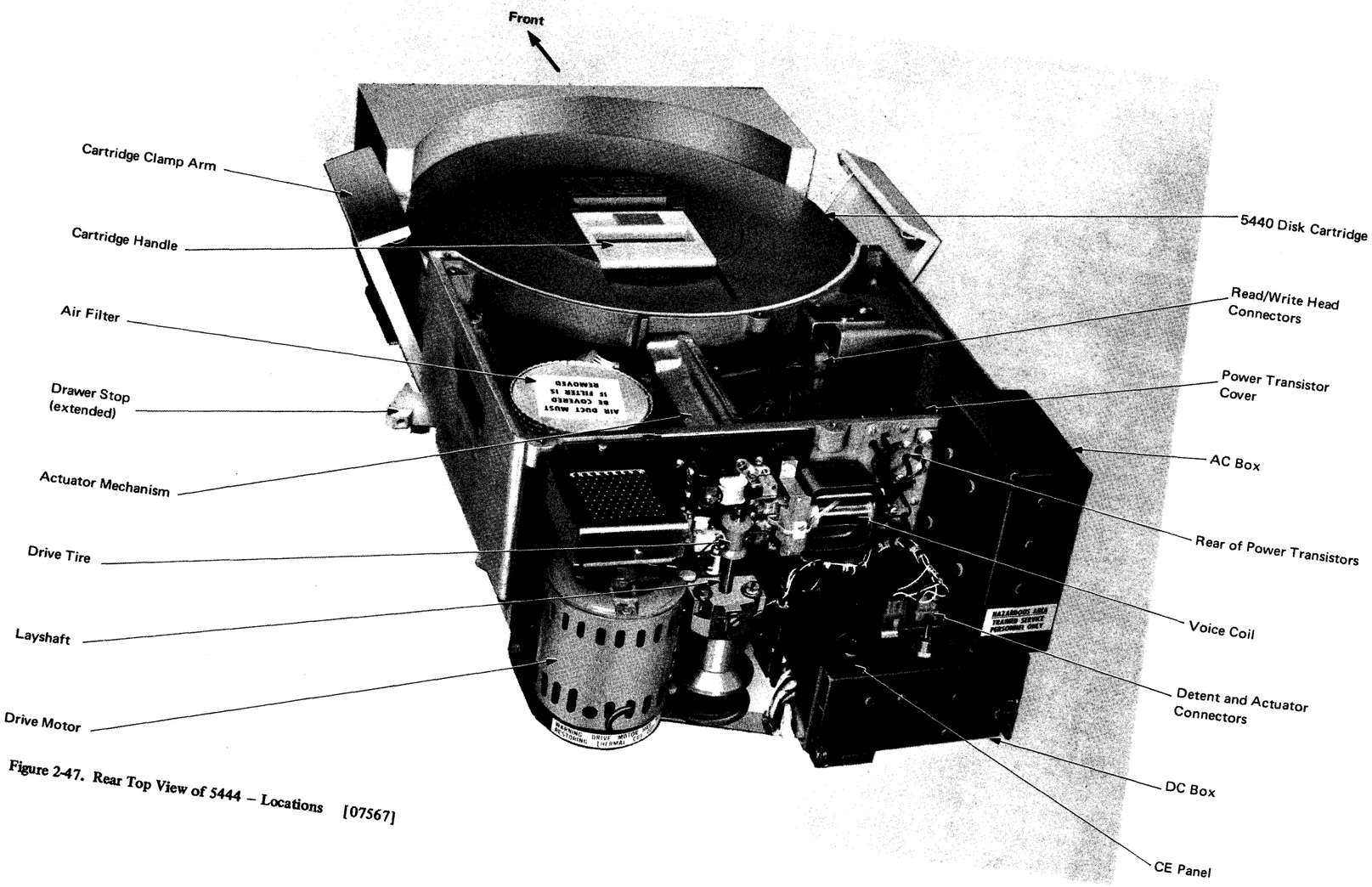


Figure 2-47. Rear Top View of 5444 – Locations [07567]

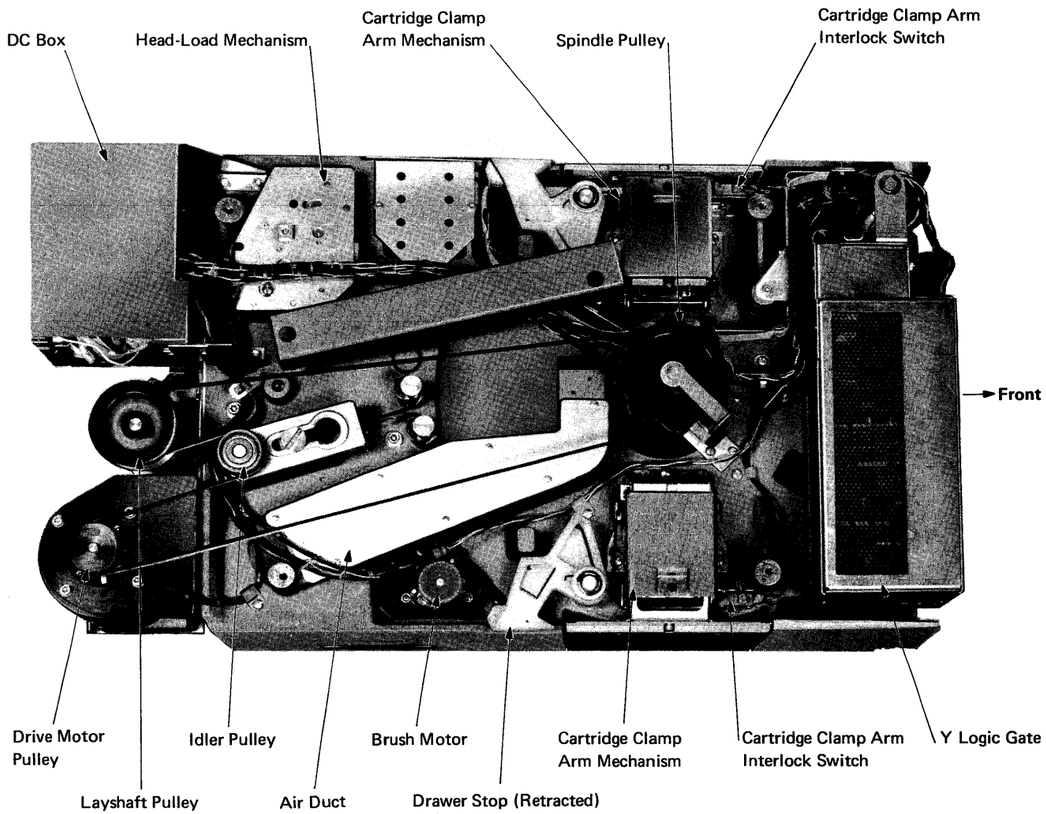


Figure 2-48. Underside View of 5444 – Locations [07568]

Appendixes and Index

Appendix B. World Trade or Domestic Differences

B.1 POWER REQUIREMENTS

The 5444 is available for use with either a 50Hz or a 60 Hz power supply. The machine index card states the power supply to which the machine has been built.

B.1.1 50 Hz Power Supply

The 50 Hz power supply is as follows:
220/235V ac ±10%, single phase.
Peak current (starting): 3.5 amperes.
Average current: 1.0 ampere.

B.1.2 60 Hz Power Supply

The 60 Hz power supply is as follows:
208/230V ac ±10%, single phase.
Peak current (starting): 3.5 amperes.
Average current: 1.0 ampere.

B.2 COMPONENTS

When the power supply frequency or voltage is changed, change the components listed in Figure B-1.

Power Supply Changed	Component to be Changed
Frequency and voltage	1. Brush motor (see 4.3.3) 2. Drive motor and drive motor pulley (see 4.2.6)
Voltage only	Drive motor (see 4.2.6)

Figure B-1. Power Supply Change – Components to be Changed [07569]

C.1 DISK ENCLOSURE ADJUSTMENTS

C.1.1 Enclosure Air Filter, PM Procedure

1. Turn off system power switch.
2. Remove connector access plate.
3. Disconnect blower.
4. Remove screws supporting blower to blower cover.
5. Rotate filter 180° (every six months for one shift usage) or replace the filter (once each year for one shift usage).
6. Assemble in reverse order.

C.1.2 Drawer Lock Bypass Procedure

CAUTION
If disk cartridge is to be removed, be sure that head cleaning brushes in the read/write heads are fully retracted.

1. Insert a small tool, approximately ½ in. (13 mm), into the lock access hole located on left side of enclosure. Use a prying motion to lift the lock while unlatching the drawer.
2. To power up the 5444 with the drawer open, activate drawer lock microswitch (see Figure C-3) by inserting the false latch, part 2590976.

C.1.3 Disk Drawer Microswitch and Latch Adjustment

1. Turn off disk drive power switch.
2. Open drawer.
3. Turn off systems power switch (to de-energize the drawer lock solenoid).
4. Remove the front drawer cover and open blower cover.
5. Slide disk drive to the rear.
6. Insert false latch so it rests on latch pin (Figure C-1).

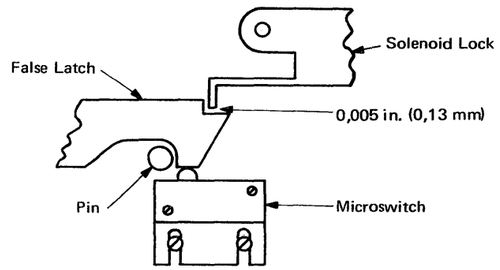


Figure C-1. False Latch Setup [07570]

7. Insert a 0.005 in. (0,13 mm) feeler gage between latching surface of the false latch and the solenoid lock. This action allows solenoid lock to operate freely with latch in place.
8. With feeler gage clamped between lock and latch surface, position the microswitch so that operating button is fully transferred to the normally closed position.
9. Remove feeler gage and false latch.
10. Slide disk into enclosure and close blower cover.
11. Install front drawer cover, keeping it square with the top and sides of the frame.
12. Check the drawer for easy closing and latching. If latch hits the pin and does not ride easily over it, adjust vertical position of latch perpendicular to the disk front cover (Figure C-2).

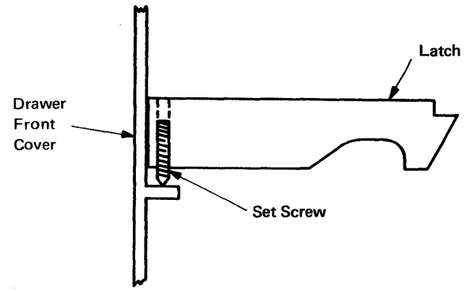


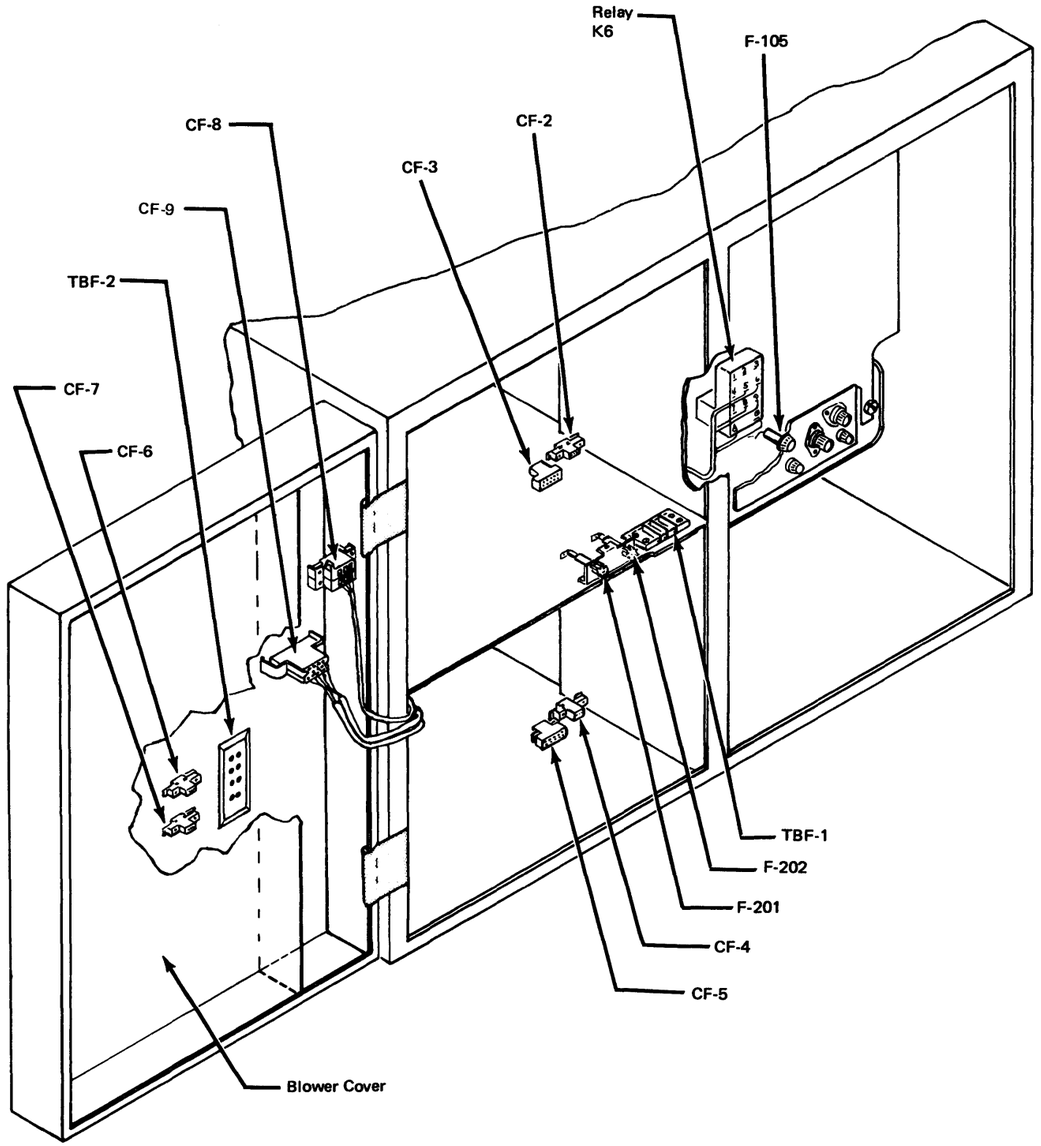
Figure C-2. Drawer Latch Adjustment [07571]

13. Check that 5444 does not drop its ready status when drawer cover is closed and latched:
    a. Close the drawer.
    b. Turn on system power switch and the disk drive start switch.
    c. Try to open drawer several times after ready indicator turns on. If ready indicator goes out, check for a defective microswitch and/or repeat the adjustment procedure.

C.2 DISK ENCLOSURE LOCATIONS

Locations in the disk enclosure are shown in Figure C-3.

Rear View



Front View

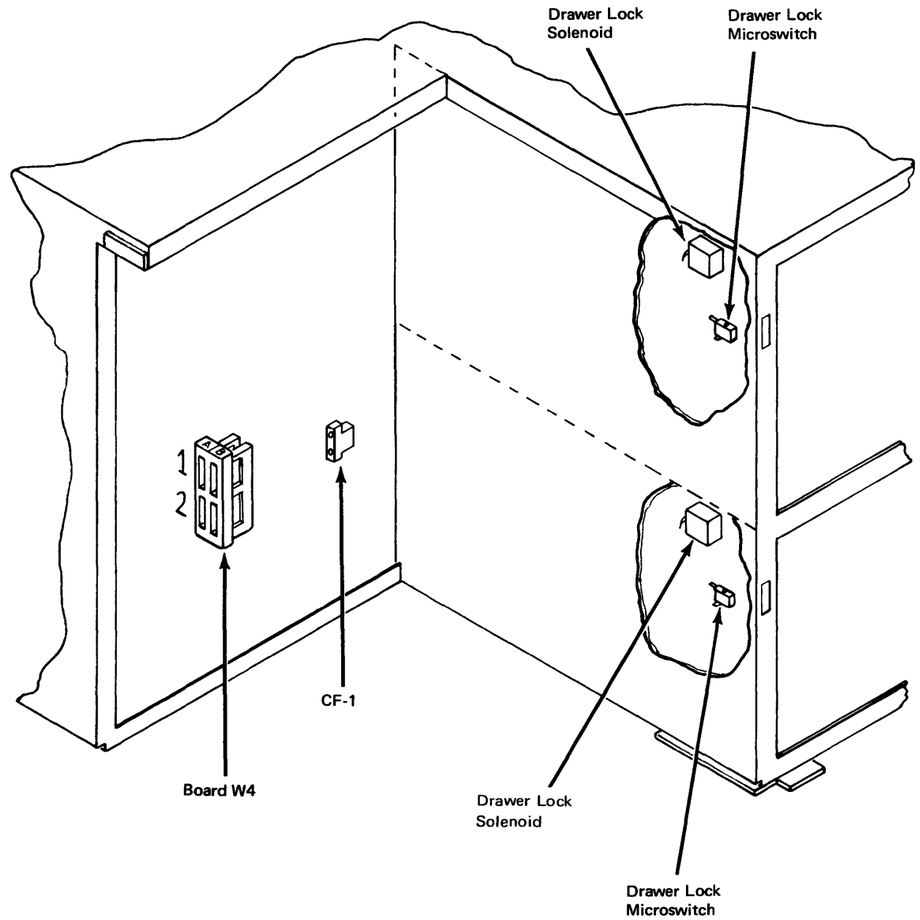


Figure C-3. Disk Enclosure Locations for IBM System/3 [07572]

Appendix D. Inches Conversion into Millimeters and Centimeters

Figure D-1 gives a table for converting inches into metric values.

Inches	Millimeters
0.001	0,025
0.002	0,051
0.003	0,076
0.004	0,102
0.005	0,127
0.006	0,152
0.007	0,178
0.008	0,208
0.009	0,229
0.010	0,254
0.020	0,508
0.030	0,762
0.040	1,016
0.050	1,270
0.060	1,524
0.070	1,778
0.080	2,032
0.090	2,286
0.100	2,540
0.200	5,080
0.300	7,620
0.400	10,160
0.500	12,700
0.600	15,240
0.700	17,780
0.800	20,320
0.900	22,860

Inches	Centimeters
1.000	2,540
2.000	5,080
3.000	7,620
4.000	10,160
5.000	12,700
6.000	15,240
7.000	17,780
8.000	20,320
9.000	22,860

Figure D-1. Conversion Table – Inches into Millimeters and Centimeters [07573]

Appendix E. Glossary of Terms

Beat Frequency: The frequency that is produced by the intermodulation of two frequencies.

Circumferential Adjustment: The adjustment of the upper index transducer to ensure that the index pulse from the transducer is in an identical position relative to the read/write heads when the disk cartridge is transferred between 5444's.

Data Rate: The nominal rate at which data can be transmitted from a 5444.

Direct Access Storage: The type of storage where information may be stored or retrieved directly without prior sequential search.

Microinch: One millionth of an inch (1×10^{-6} inch)

Micron: One millionth part of a meter (1×10^{-6} meter) Equivalent to 39.4 microinches.

Period: The time between consecutive pulses.

Reluctance: The ratio that the magnetomotive force acting around a magnetic circuit bears to the flux that produces this force.

Runout: The total up-and-down vertical movement at the disk edge during one revolution.

SLD-100: A specification for voltages that are used in solid logic dense construction.

Tracking Adjustment: An adjustment to ensure that the read/write heads move in a true radial line across the disk surfaces.

W

Y

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