CONTENTS

FRAME LOCATION TABLE

Page	Frame	Card
1-1	B07	1-1
1-2	B09	1-1
1-3	B13	1-1
1-4	B15	1-1
1-5	B17	1-1
1-6	C01	1-1
1-7	C03	1-1
1-8	C05	1-1
1-9	C07	1-1
1-10	C09	1-1
1-11	C11	1-1
1-12	C13	1-1

CONTENTS

FRAME LOCATION TABLE

Page	Frame	Card
1-12	C13	1-1
1-13	C15	1-1
1-14	C17	1-1
1-16	D03	1-1
1-17	D05	1-1
1-18	D07	1-1
1-19	D09	1-1
1-21	D13	1-1
1-22	D15	1-1
1-24	E01	1-1
1-25	E03	1-1
1-26	E05	1-1
1-27	E07	1-1
1-29	E11	1-1
1-31	E17	1-1
1-33	B02	1-2

CONTENTS

FRAME LOCATION TABLE

Page	Frame	Card
1-33	B02	1-2
1-34	B06	1-2
2-1	B09	1-2
2-2	B11	1-2
2-9	C04	1-2
2-10	C06	1-2
2-11	C09	1-2

CONTENTS

FRAME LOCATION TABLE

Page	Frame	Card
2-11	C09	1-2
2-12	C11	1-2
2-13	C13	1-2
2-15	C17	1-2
2-16	D01	1-2
2-18	D05	1-2
2-20	D09	1-2
2-21	D11	1-2
2-22	D14	1-2
2-23	D16	1-2
2-25	E03	1-2
2-26	E05	1-2
2-27	E07	1-2
2-28	E09	1-2
2-30	E13	1-2
2-31	E15	1-2
2-32	E17	1-2
2-33	B01	1-3
2-35	B07	1-3
2-36	B09	1-3
2-37	B11	1-3
2-40	C01	1-3

CONTENTS

Appendixes and Index

FRAME LOCATION TABLE

Page	Frame	Card
2-40	C01	1-3
2-41	C03	1-3
2-43	C07	1-3
2-45	C11	1-3
B-1	C15	1-3
C-1	C17	1-3
E-1	D04	1-3
INDEX-	A09	1-1, 1-2, 1-3

ILLUSTRATIONS

Part 1. Theory

FRAME LOCATION TABLE

Page	Frame	Card
1-1---	B07---	1-1
1-2---	B09---	1-1
1-3---	B13---	1-1
1-4---	B15---	1-1
1-5---	B17---	1-1
1-6---	C01---	1-1
1-7---	C03---	1-1
1-8---	C05---	1-1
1-9---	C07---	1-1
1-10--	C09---	1-1
1-11--	C11---	1-1
1-12--	C13---	1-1
1-13--	C15---	1-1
1-14--	C17---	1-1
1-15--	D01---	1-1
1-16--	D03---	1-1
1-17--	D05---	1-1
1-18--	D07---	1-1
1-19--	D09---	1-1
1-20--	D11---	1-1
1-21--	D13---	1-1
1-22--	D15---	1-1
1-23--	D17---	1-1

ILLUSTRATIONS

Part 2. Maintenance

FRAME LOCATION TABLE

Page	Frame	Card
1-23	D17	1-1
1-24	E01	1-1
1-25	E03	1-1
1-26	E05	1-1
1-27	E07	1-1
1-28	E10	1-1
1-29	E11	1-1
1-30	E13	1-1
1-31	E17	1-1
1-34	B06	1-2
2-1	B09	1-2
2-4	B13	1-2
2-5	B15	1-2
2-6	B17	1-2
2-7	C01	1-2
2-9	C04	1-2
2-10	C06	1-2
2-11	C09	1-2
2-12	C11	1-2
2-13	C13	1-2
2-15	C17	1-2
2-16	D01	1-2
2-17	D03	1-2
2-18	D05	1-2
2-19	D07	1-2

ILLUSTRATIONS

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.

FRAME LOCATION TABLE

Page	Frame	Card
2-20	D09	1-2
2-21	D11	1-2
2-22	D14	1-2
2-23	D16	1-2
2-24	E01	1-2
2-25	E03	1-2
2-26	E05	1-2
2-27	E07	1-2
2-28	E09	1-2
2-29	E11	1-2
2-30	E13	1-2
2-31	E15	1-2
2-32	E17	1-2
2-33	B01	1-3
2-34	B05	1-3
2-35	B07	1-3
2-36	B09	1-3
2-37	B11	1-3
2-38	B13	1-3
2-40	C01	1-3
2-41	C03	1-3
2-43	C07	1-3
2-45	C11	1-3
2-46	C13	1-3
B-1	C15	1-3
C-1	C17	1-3
D-1	E02	1-3

INDEX

INDEX

INDEX

INDEX

INDEX

INDEX

CONTINUED ON
FRAME B01

CONTINUED ON
FRAME B01

IBM Maintenance Library

5444 Disk Storage Drive
(Machines with serial no. up to 30100)
Theory-Maintenance

SY33-0026-1

B01

Preface

This manual provides, for maintenance personnel, instructional information on the IBM 5444 Disk Storage Drive (machines with serial numbers up to 30100). 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 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 IBM technical operations departments as the need arises and are available from IBM branch offices.
5. IBM Maintenance Library, *5444 Disk Storage Drive (Machines with serial no. below 30100), 5440 Disk Cartridge, Parts Catalog*, Order No. S135-0001.

Safety

A page of safety procedures, for both personnel and equipment, precedes Part 1 of the manual.

Third Edition (April, 1971)

This is a major revision of, and obsoletes, SY33-0026-0. Technical changes and additions to the text and illustrations are indicated by a vertical line to the left of the change. The format of the manual has been modified to improve useability.

Changes are continually made to the information herein; any such changes will be reported in subsequent revisions or Technical Newsletters.

Requests for copies of IBM publications should be made to your IBM representative or to the IBM branch office serving your locality.

Comments and Suggestions

A form for your comments and suggestions is provided at the back of this publication. If the form has been removed, they may be sent to IBM United Kingdom Laboratories Ltd., Product Publications, Hursley Park, Winchester, Hants, England. Comments and suggestions become the property of IBM.

Safety Procedures

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*, Order No. S229-1264 (shown on right). This card is 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.

Brush Mechanism: If the arm that carries the brushes has to be manually retracted, first remove the spring clip securing the arm, otherwise the retraction mechanism can be permanently damaged.

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

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. *Never fit a suspected cartridge to another 5444. Never fit another cartridge to a suspected 5444.*

Disk Damage:

1. If the 5444 produces tinkling or screeching sounds, immediately inspect the disks and the read/write heads.
2. Protect the coated surfaces of the disks 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.
3. 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.

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 straboscope — 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 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

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: Handle and store with extreme care all components contributing to the accuracy of the actuator and carriage. In particular, keep the leadscrew, follower, and ball slides free from contamination. Store the head arm assemblies 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.

Separated Grounds: Most of the 5444 is dc grounded; the using system enclosure is usually ac grounded. Therefore, make sure that the 5444 is always electrically isolated from the enclosure of the using system.

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

Y Gate: Make sure that the Y gate pins, protected by oval connector blocks, are not connected to ground, or else the detent voice coil will be permanently damaged. The pins are listed in Part 2, Chapter 1, Section 2.

INTRODUCTION

B06

1. Introduction

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.**
- **An IBM 5440 Disk Cartridge is used as a removable upper disk.**
- **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.

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 (nominal).

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 (nominal).

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 (nominal).

Major Units

- **The major units are described in detail in Part 1, 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 is contained in the removable 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. The cartridge may be easily removed from the 5444 and can be fitted to other 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

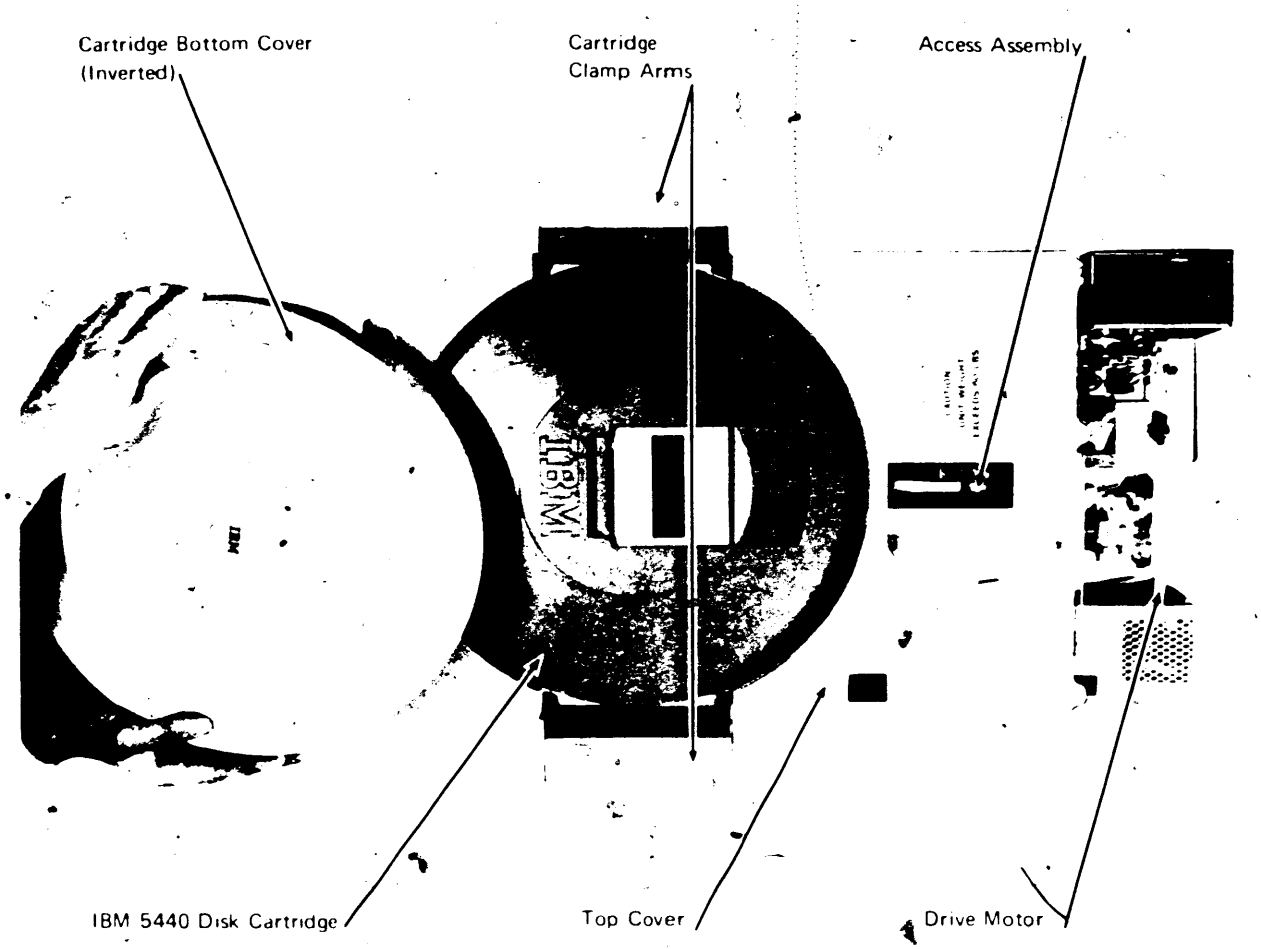


Figure 1-1. IBM 5444 Disk Storage Drive [07461]

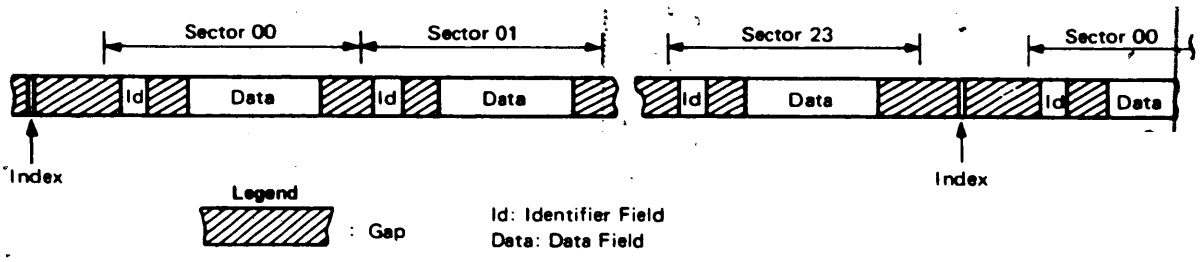


Figure 1-2. Track Format for System/3 [07462]

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. *Forward* movement of the heads is towards the disk center; *reverse* movement is away from the disk center. 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 Part 1, 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

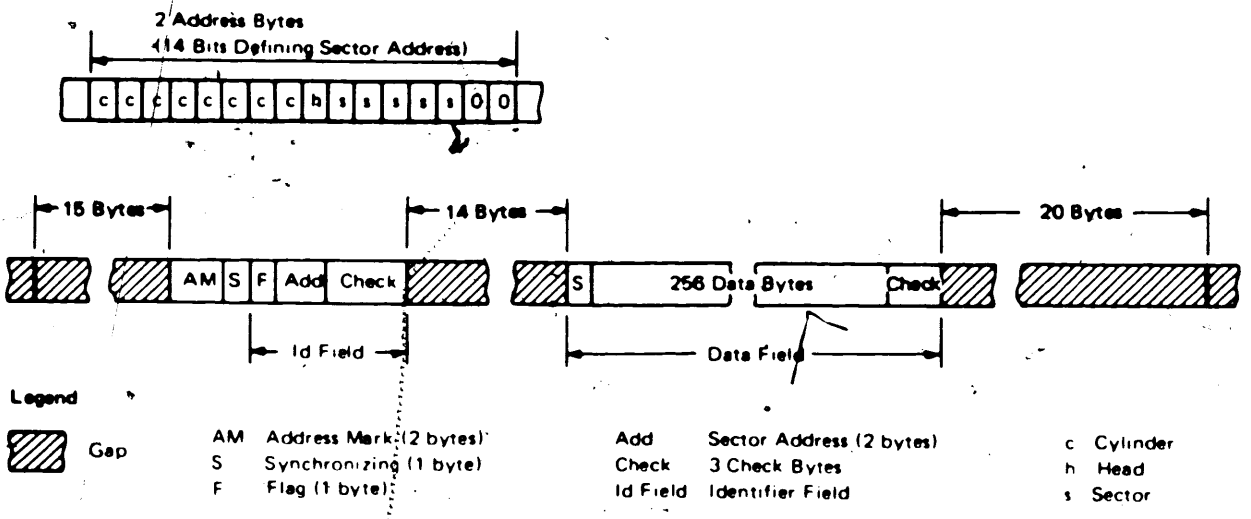


Figure 1-3. Sector Format for System/3 [07463]

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 for IBM System/3

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

The track format for IBM System/3 is shown in Figure 1-2. Fr. A09 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 for System/3

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

The sector format for System/3 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.

CONTINUED ON
FRAME B12

FUNCTIONAL

UNITS

B12

2. Functional Units

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 Fr. B15 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.

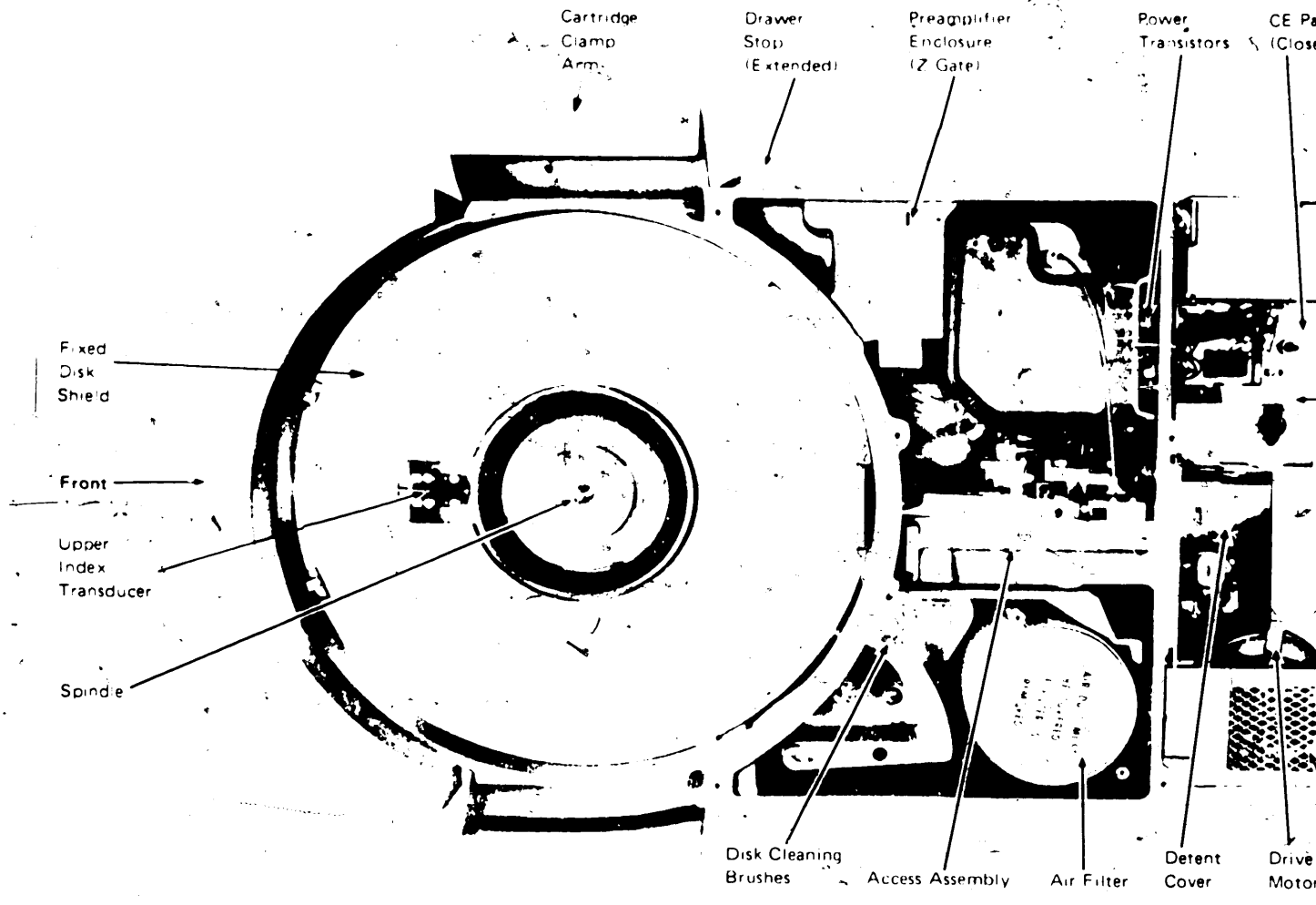


Figure 1-4. Component Layout – Top View [07464A]

the disk cham-
filter removes

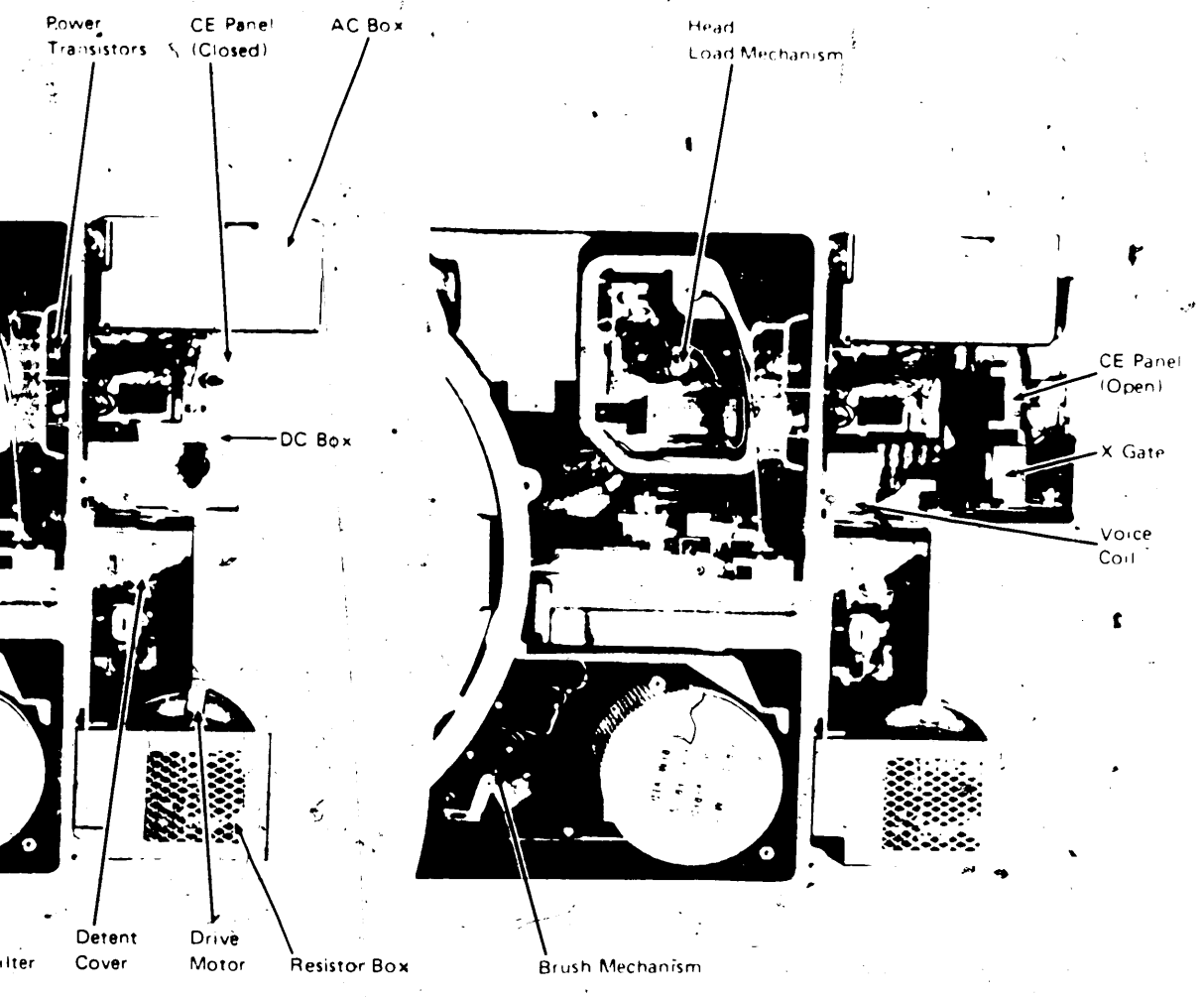
disk hub assist

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) **Fr. B15** 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.

Impeller blades below the lower disk hub assembly force air through the filter and back through the return duct to the disk chamber. A deflector plate ensures a streamline airflow through the filter and prevents dust particles from re-entering the disk chamber.

View of Head Load and Brush Mechanisms – Covers Removed



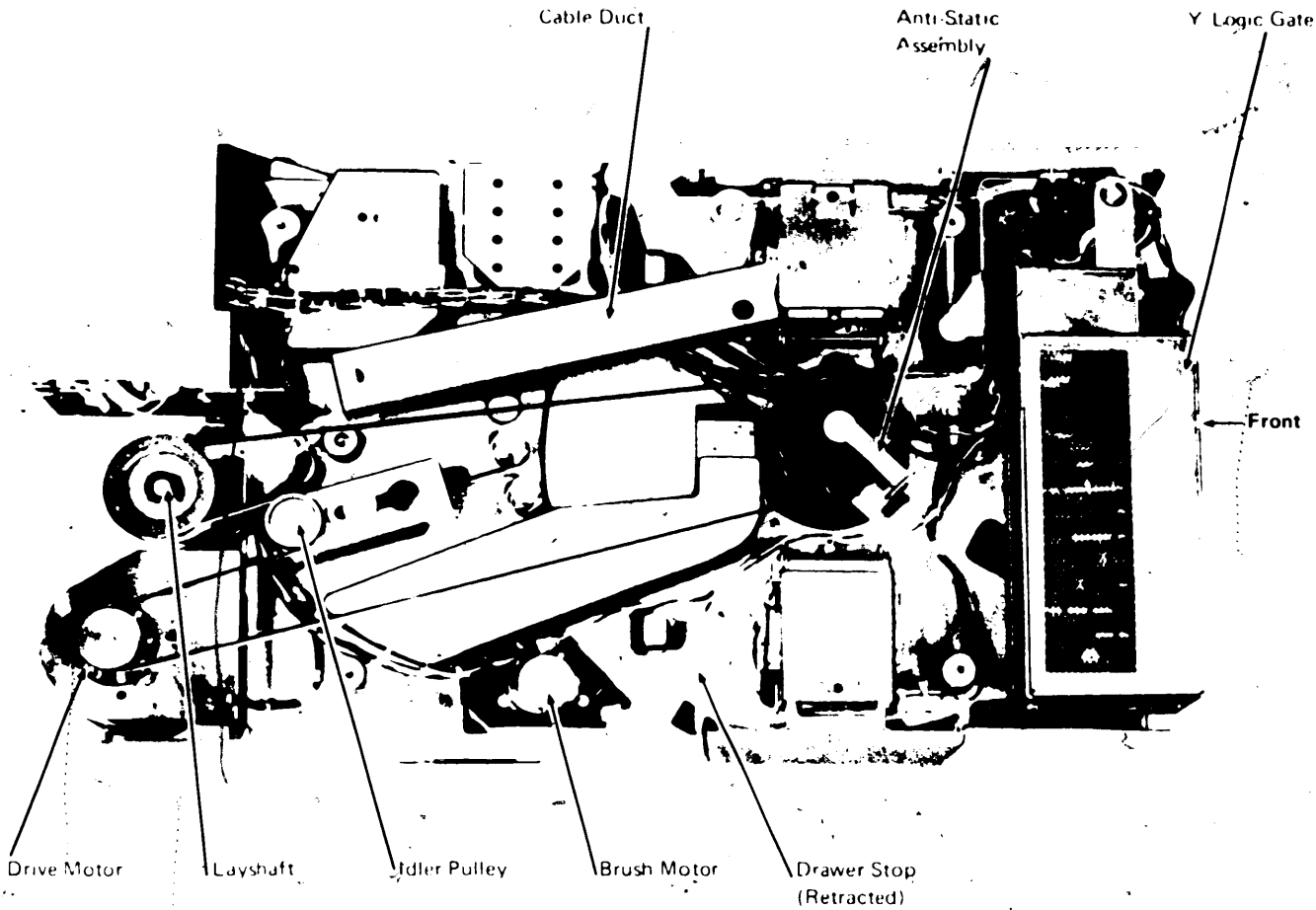
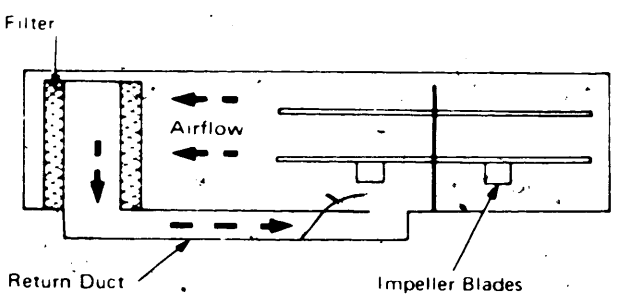


Figure 1-5. Component Layout — Underside View [07468A]



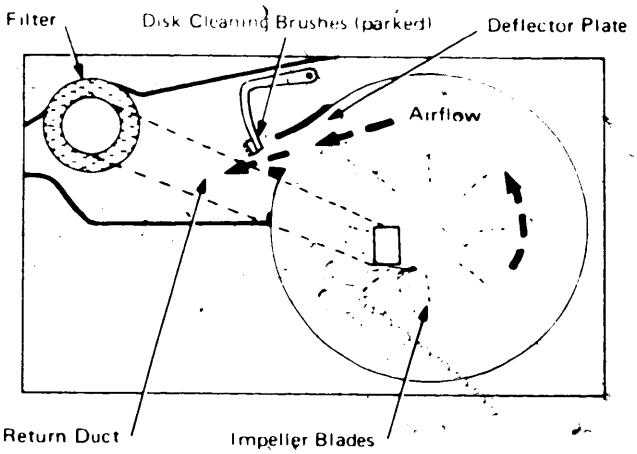


Figure 1-6. Air Circulation System [07466A]

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).

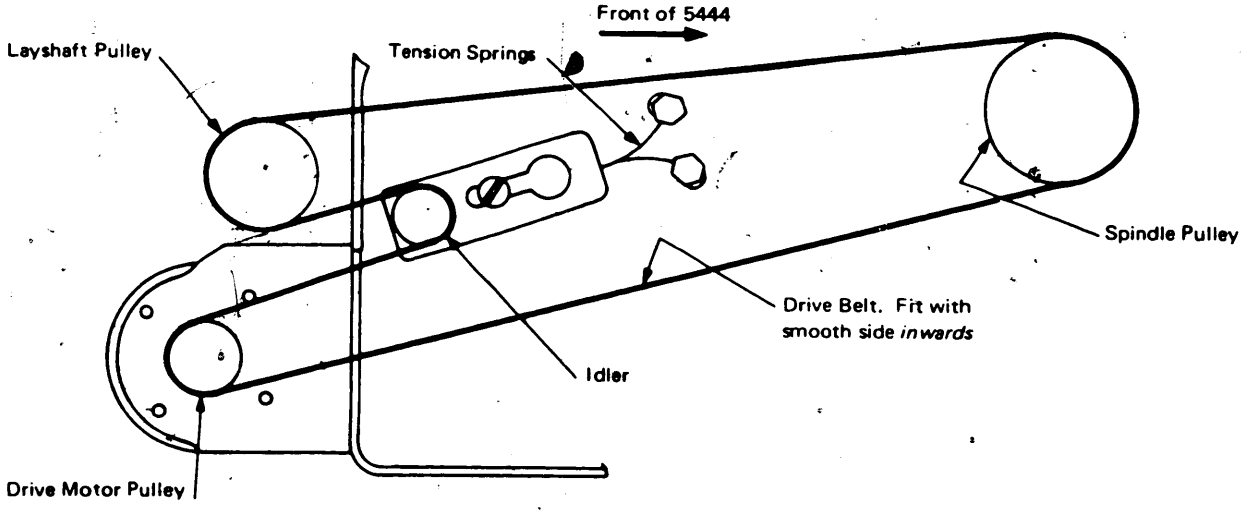


Figure 1-7. Motor Drive (Schematic) [07467]

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 (early models) or slot (late models) in 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.

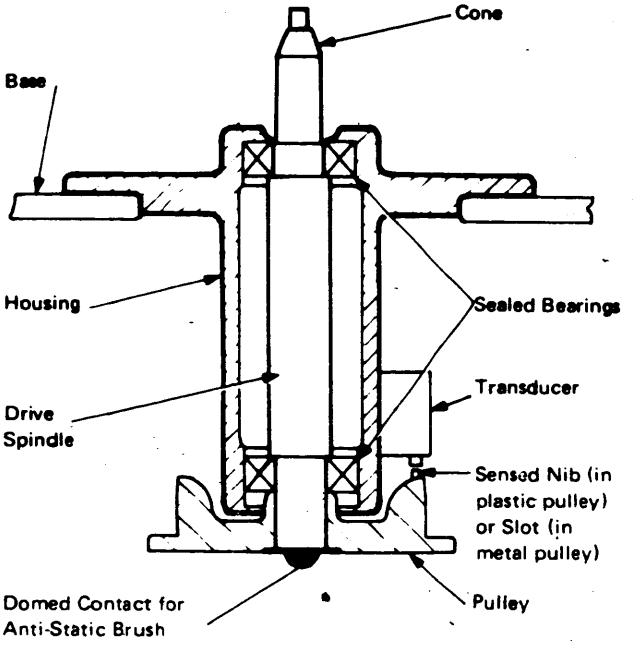


Figure 1-8. Drive Spindle [07468A]

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 integral with the drive spindle.

The fixed lower disk is secured on the hub assembly by a clamp ring (Figure 1-9). Fr. B18 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) Fr. B18 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.

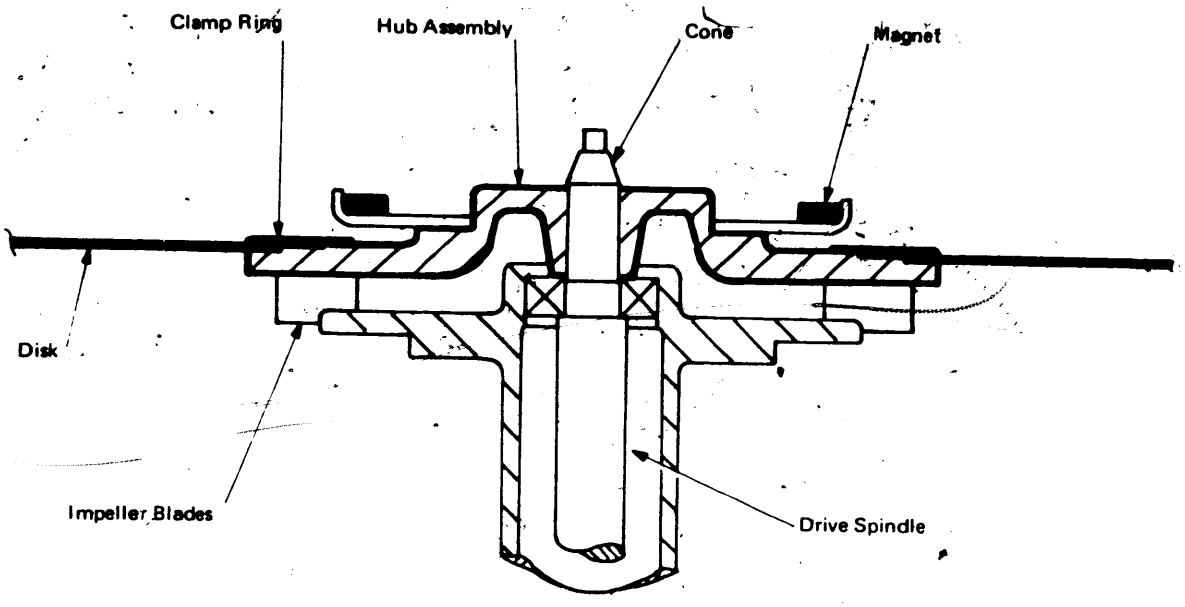


Figure 1-9. Lower Disk Hub Assembly [07469]

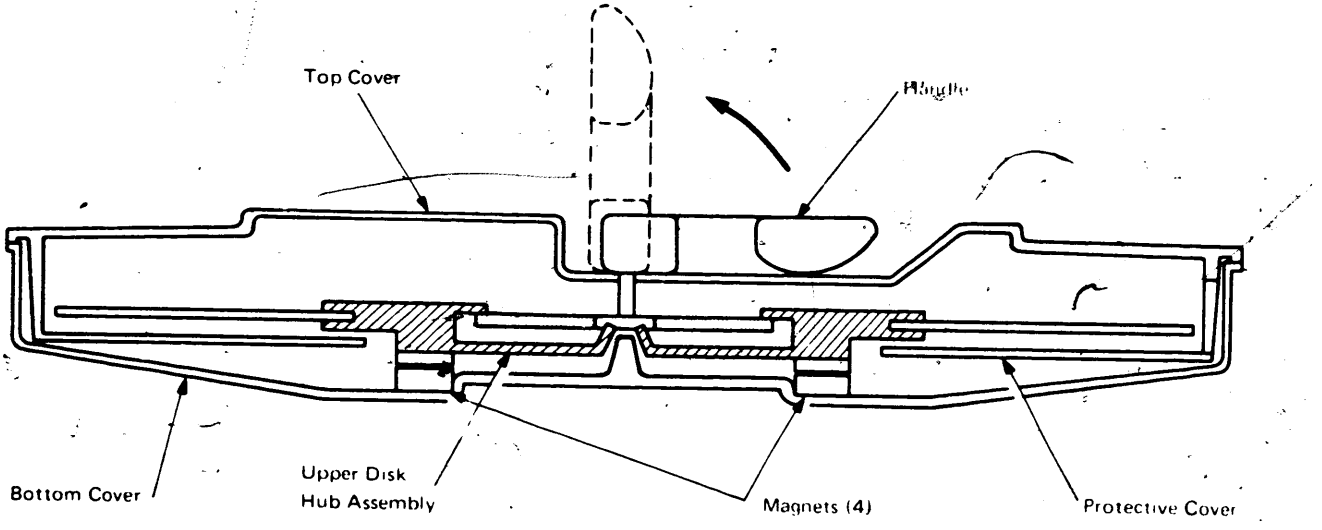


Figure 1-10. 5440 Disk Cartridge [07470A]

A clamp ring secures the disk to the upper disk hub assembly (Figure 1-11) **Fr. C01** 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). **Fr. C01**

For storage, the removable disk is placed in the cartridge bottom cover; the armature ring clamps onto four magnets (see Figure 1-13) **Fr. C02** 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.

CONTINUED ON FRAME C01

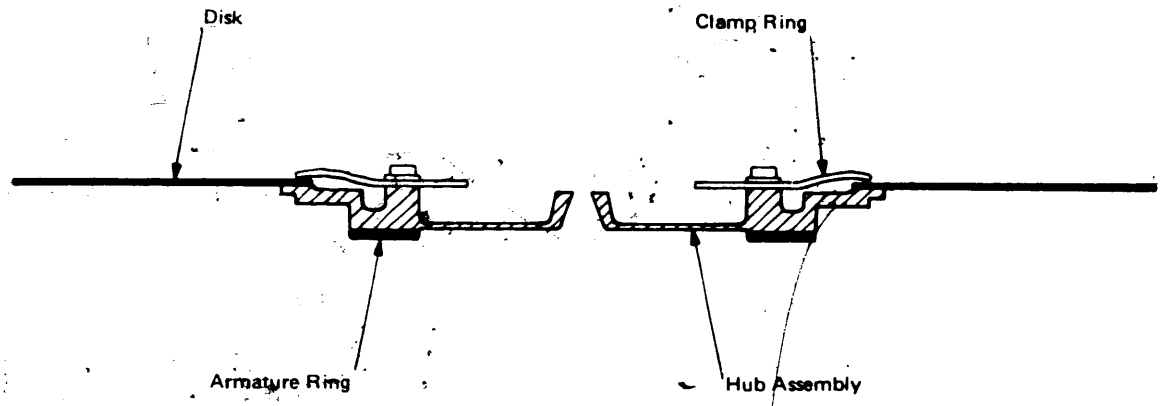


Figure 1-11. Upper Disk Hub Assembly [07471]

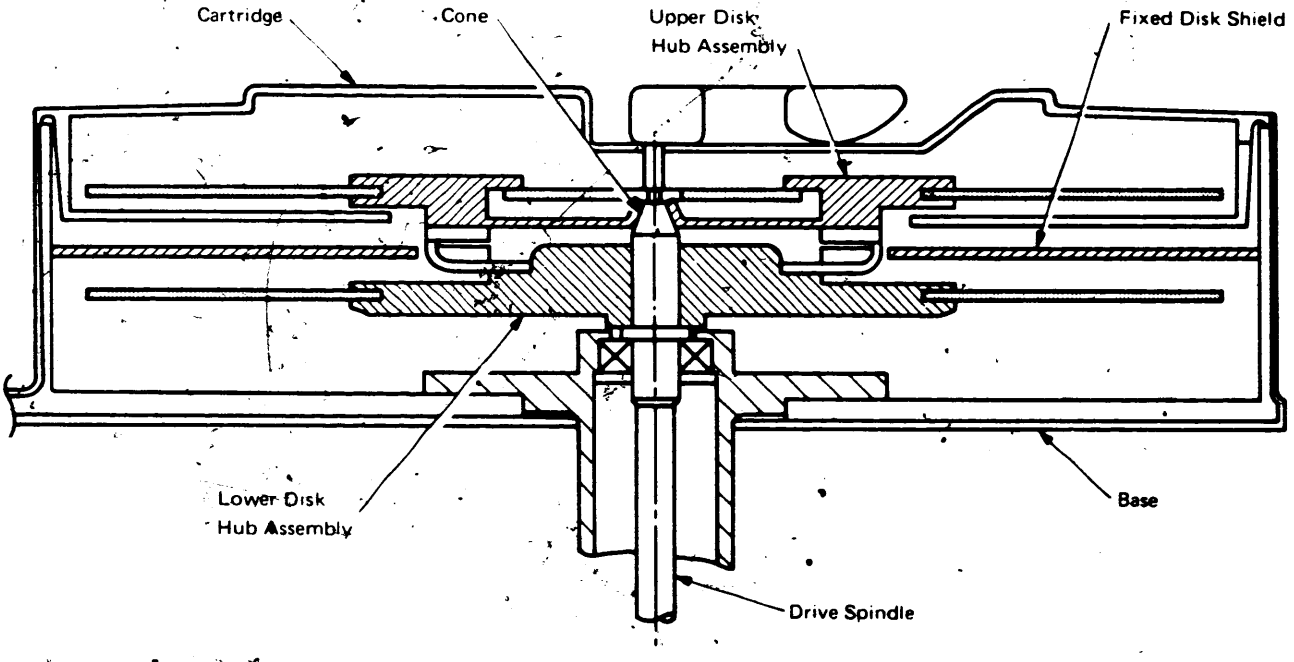


Figure 1-12. Cartridge on Drive Spindle [07472]

5440 DISK CARTRIDGE

- The disk cartridge is held in position on the machine by two cartridge clamp arms.
- When the cartridge is installed, its bottom cover is stored on top of the cartridge.
- 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 top cover 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 top cover, a head entry port and a brush entry port are provided in its side wall. Four keyways in the side wall ensure correct location of these ports.

When removed from the machine, the top cover is placed in a bottom cover (see Figure 1-10). Four pot 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 cartridges may be used in any model of 5444.

Cartridge Clamp Arms

When the cartridge is in use, the bottom cover is inverted to fit on top of the cartridge. 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 is 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 latch (Figure 1-13) must be held against its spring; rotation of the handle then forces

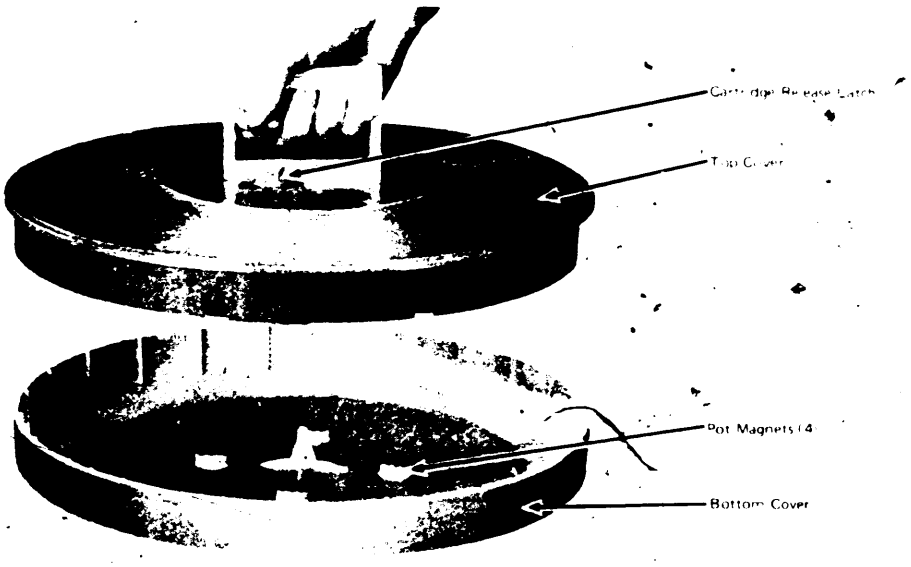


Figure 1-13. Cartridge Handle and Release Latch [07473A]

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.

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.**
- **The 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 Fr. C04 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 retracted (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. The brush motor is activated by the '+24V file start' line. The cam operates the 'brush cycle complete' microswitch and stops the brush motor. If a *reversible* brush mechanism is fitted (Figure 1-15), it causes the brush motor to stall against the forward stop and to reverse to the retracted stop; if a *unidirectional* brush mechanism is fitted (see Figure 1-15), it makes one complete revolution to the retracted stop. Both types take one minute to cycle.

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). Fr. C05

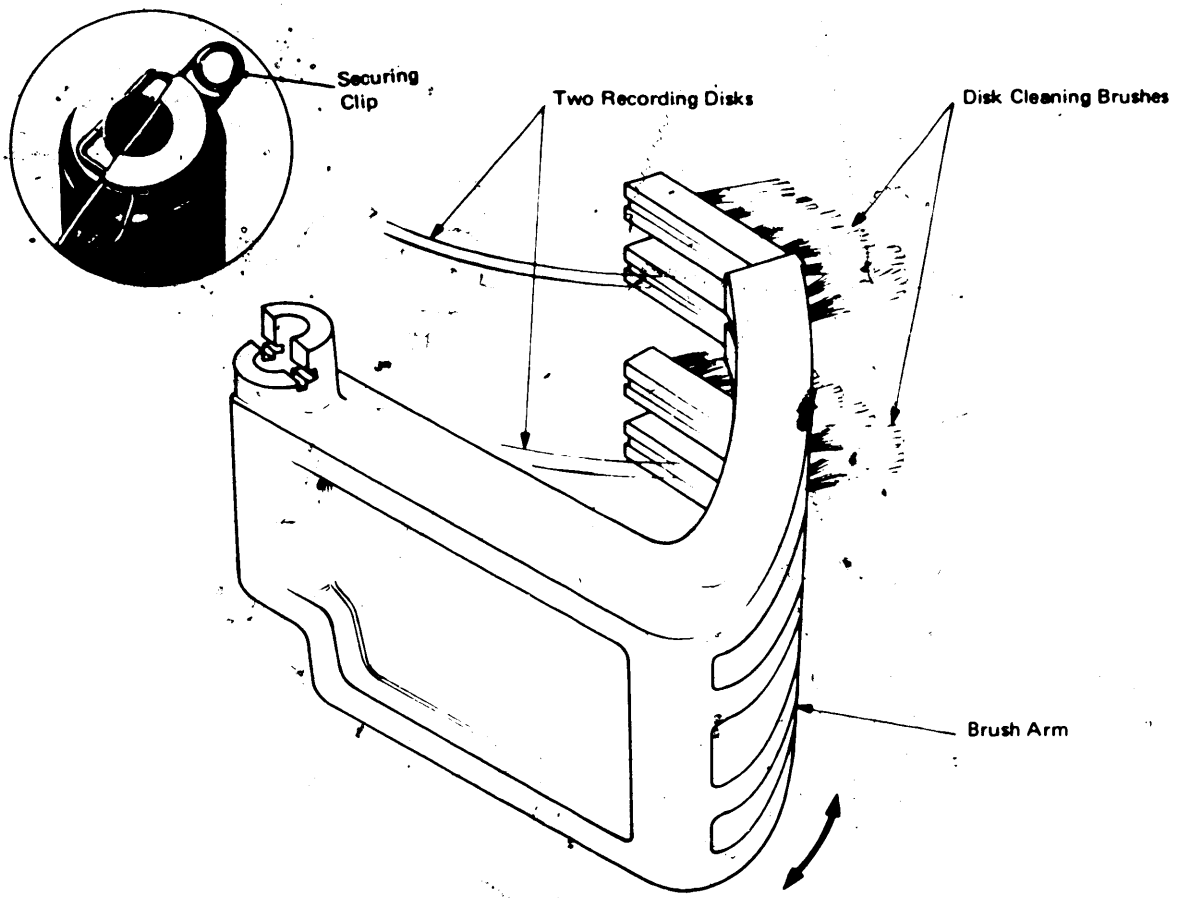
Brush Motor

The brush motor is of the synchronous type. Because the 5444 can be operated from 50 Hz and 60 Hz power supplies, different brush motor assemblies are needed (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.**

C03



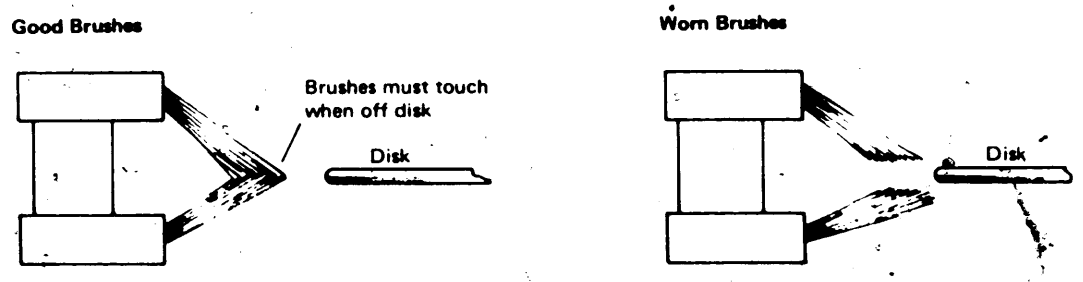


Figure 1-14. Disk Cleaning Brushes [07474]

Reversible Brush Mechanism (50-Hz Machines)

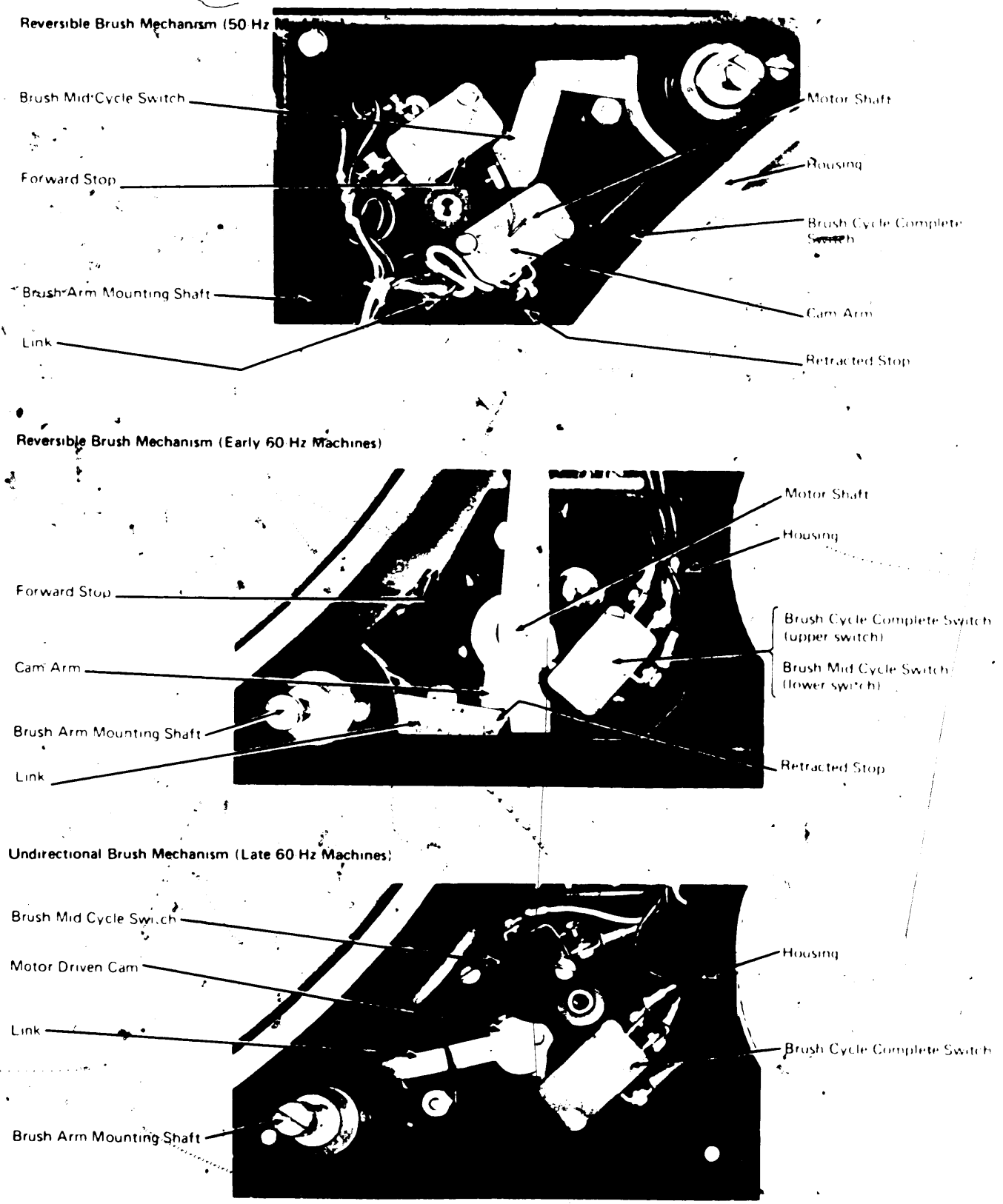


Figure 1-15. Linkage Mechanism for Disk Cleaning Brushes [08429]

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 shutting its limits of travel.

Four head load spring shafts (Figure 1-17) Fr. C07 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 knockoff (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.**

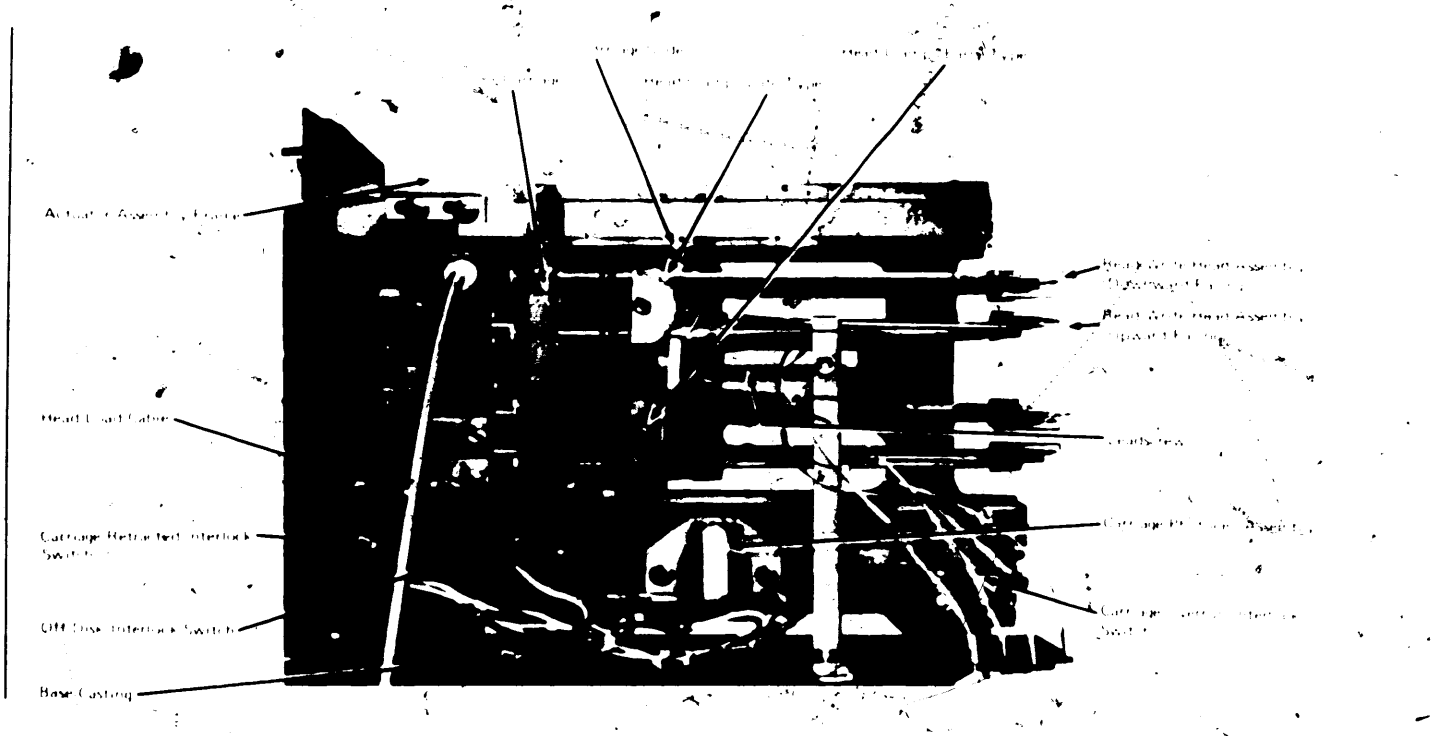


Figure 1-16. Actuator Assembly [08430]

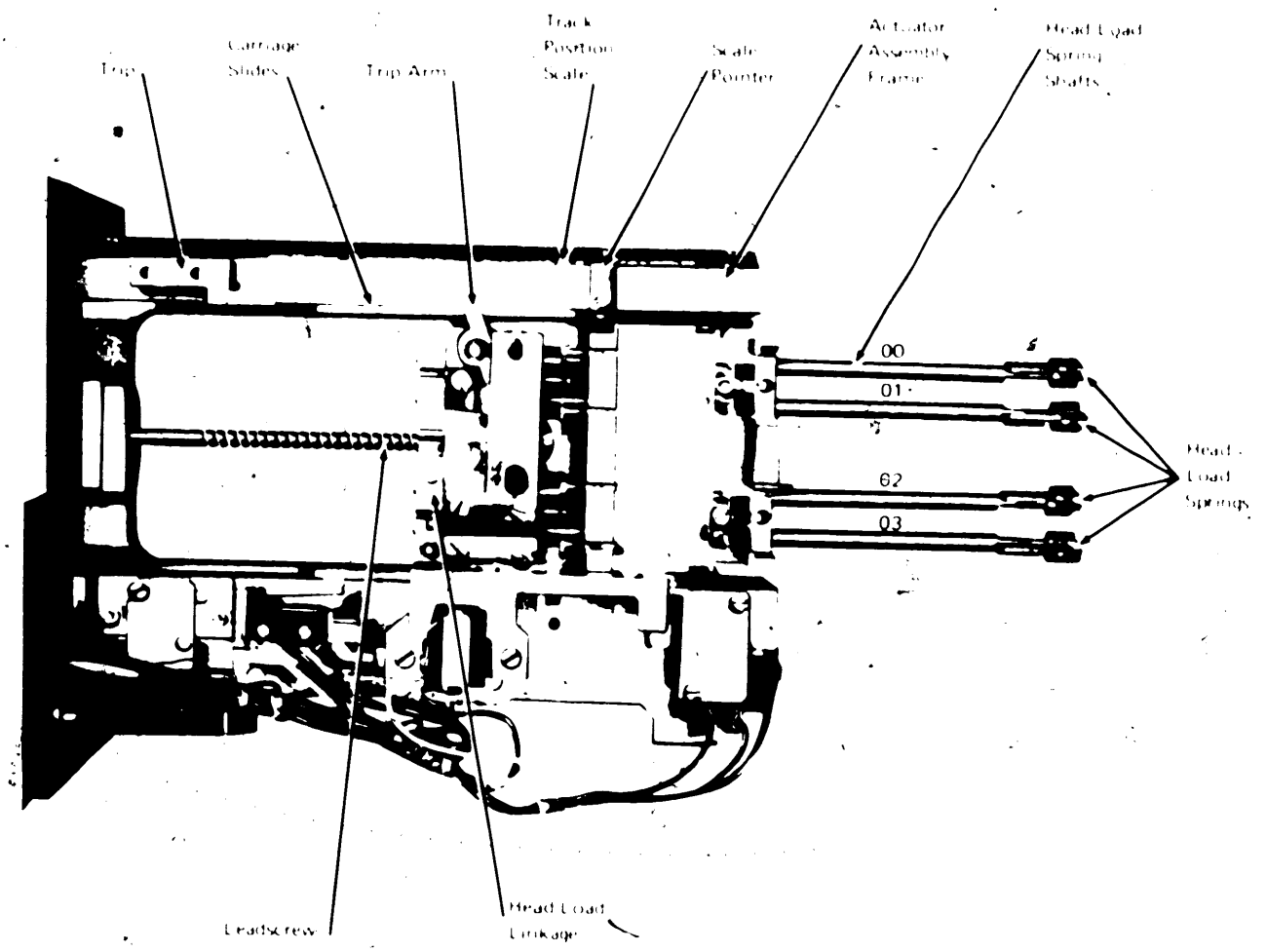


Figure 1-17. Carriage and Actuator Assembly — Without Heads (1054-1)

The carriage is driven along the actuator frame by a leadscrew acting on a spring-loaded follower wheel and rollers attached to the carriage (Figure 1-18). Fr. C08 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). Fr. C08

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

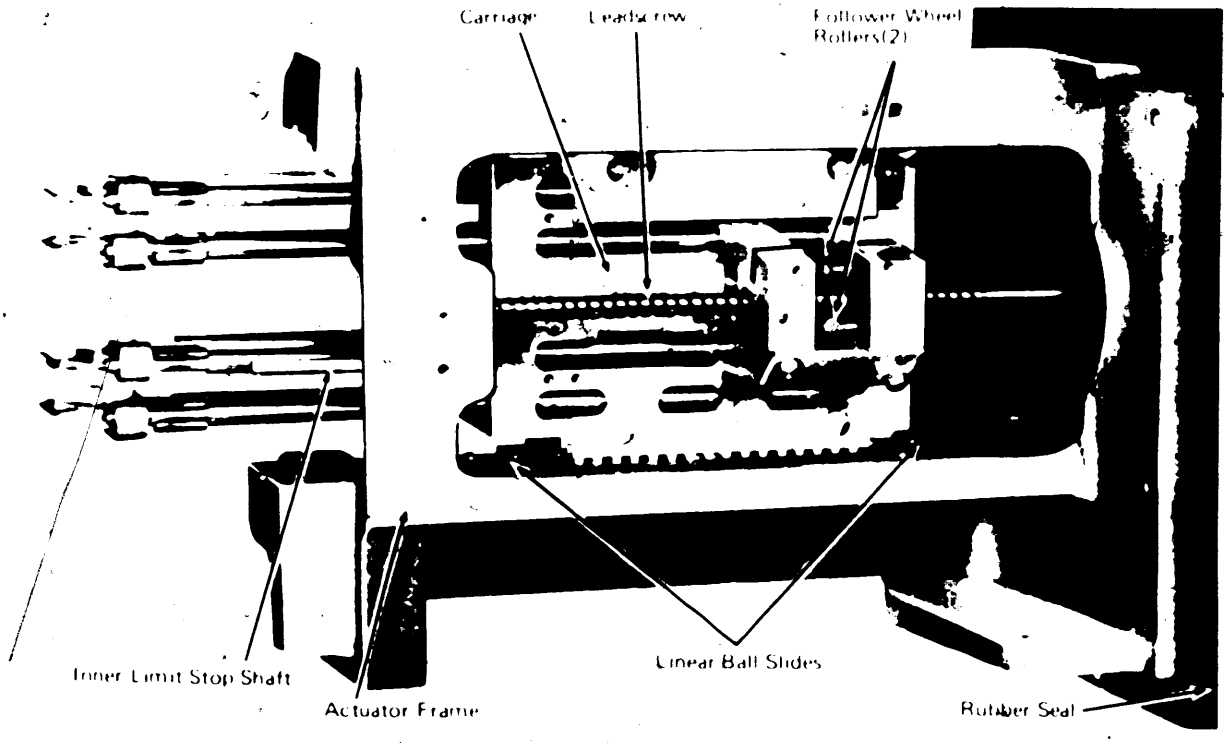


Figure 1-18. Leadscrew and Follower [02428]

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 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.**

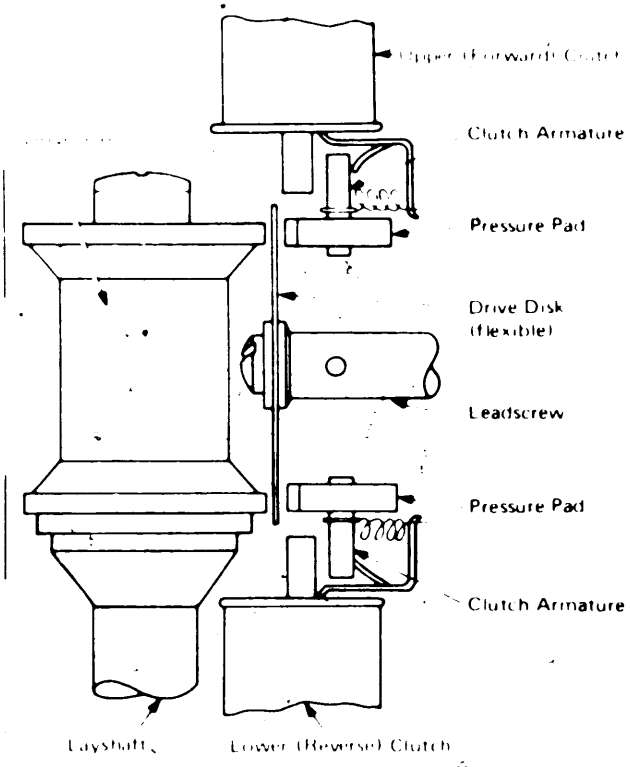


Figure 1-19. Layshaft Leadscrew Drive [02479A]

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) Fr. C10 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

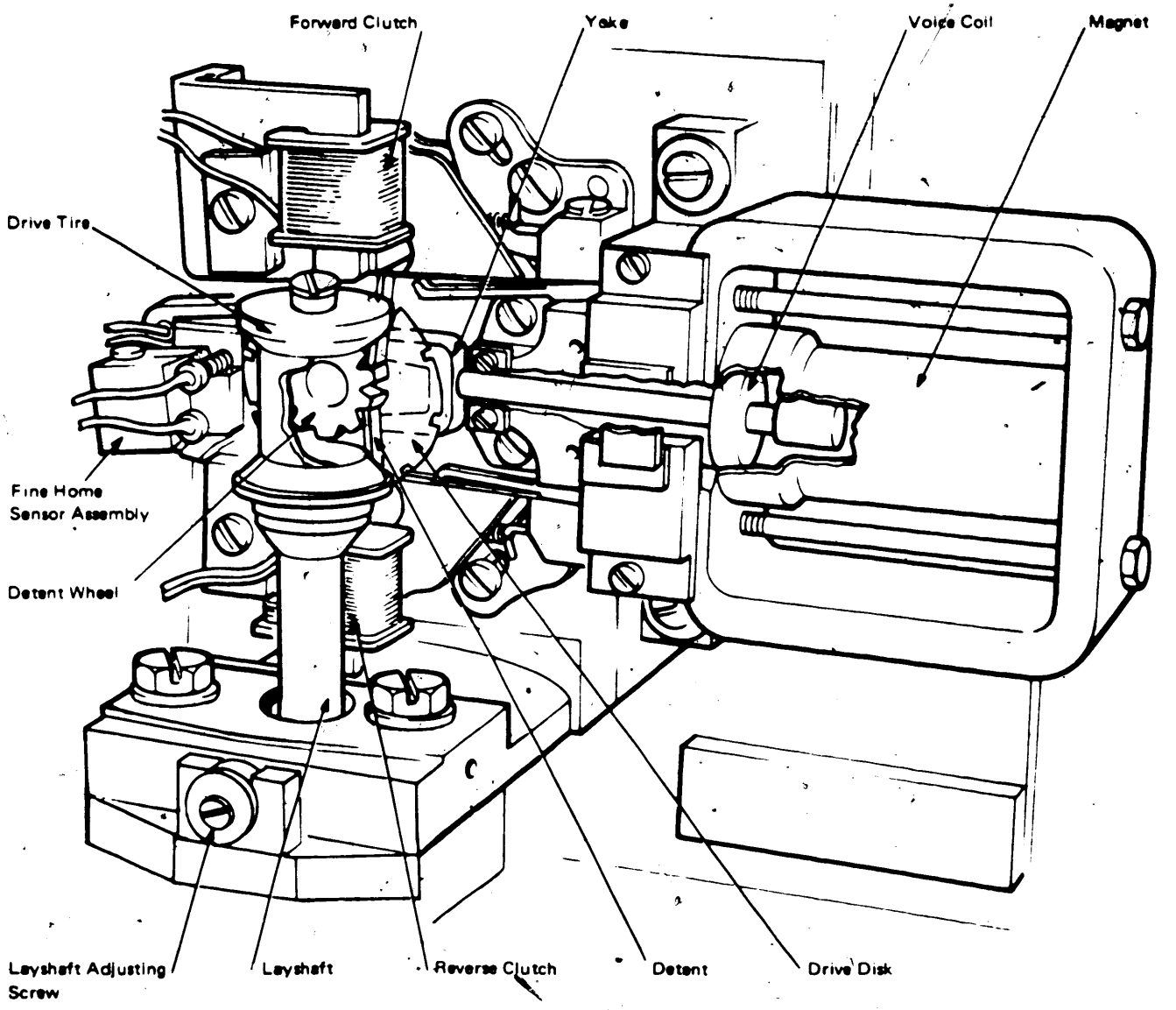
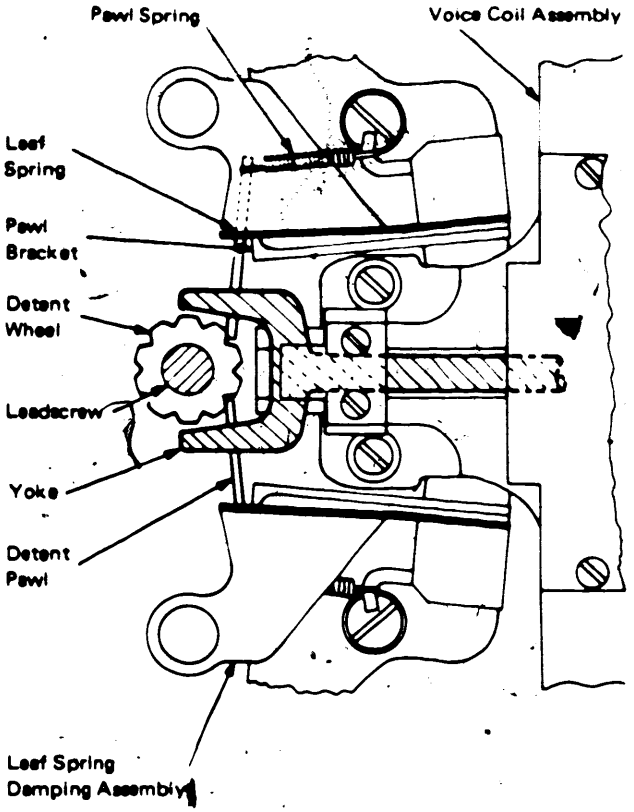


Figure 1-20. Detent Mechanism [074780A]



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

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

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.

HEAD/ARM ASSEMBLY

- The head/arm assembly (Figure 1-22) Fr. C11 consists of a read/write head, support arm, and connecting cable and plug.
- The four head/arm assemblies are clamped 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.
- The erase coil follows the read/write coil to trim the edges of the written data tracks.

The read/write head (Figure 1-23) Fr. C12 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.

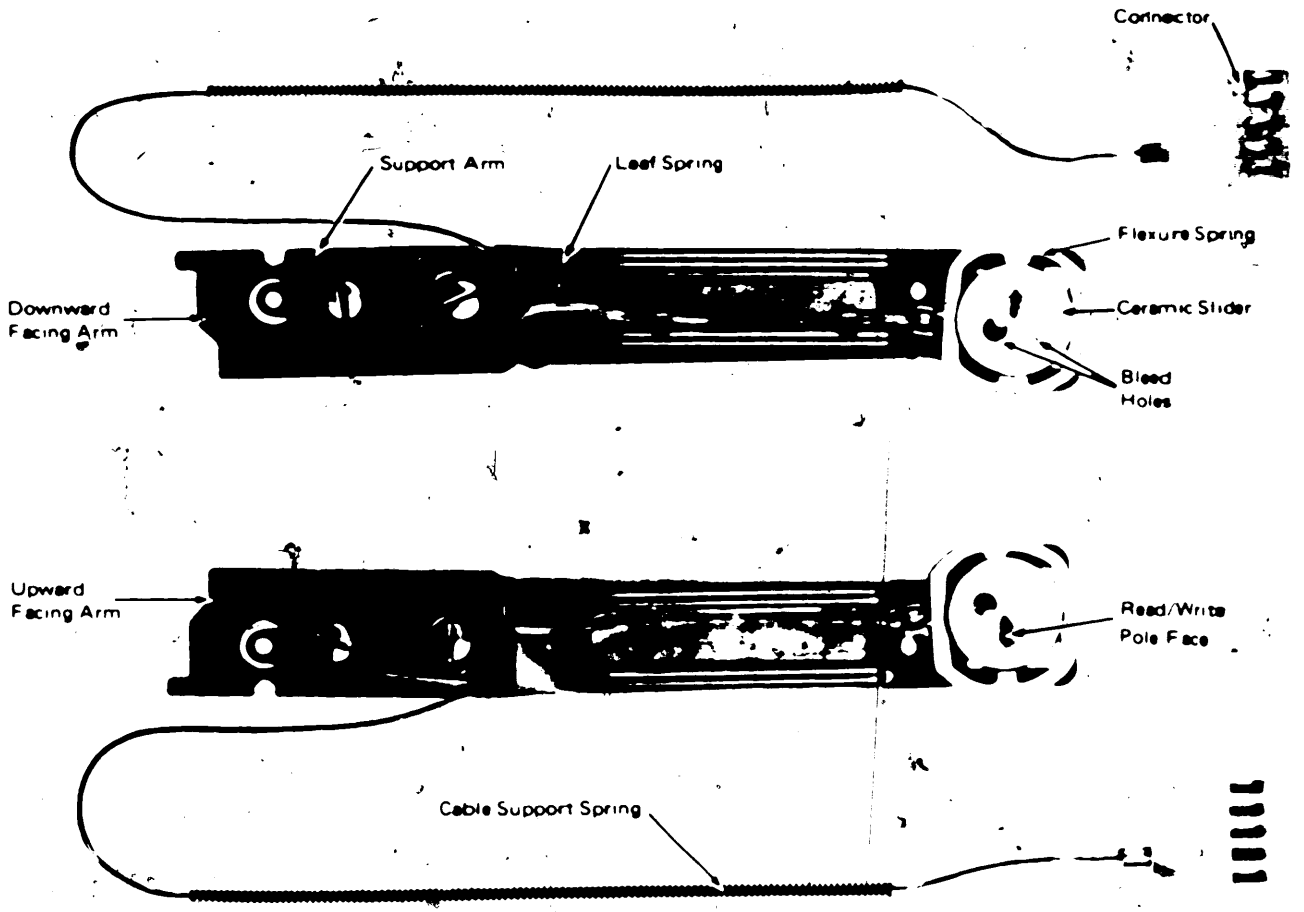


Figure 1-22. Head Arm Assembly [07483]

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 (see Figure 1-22). 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.

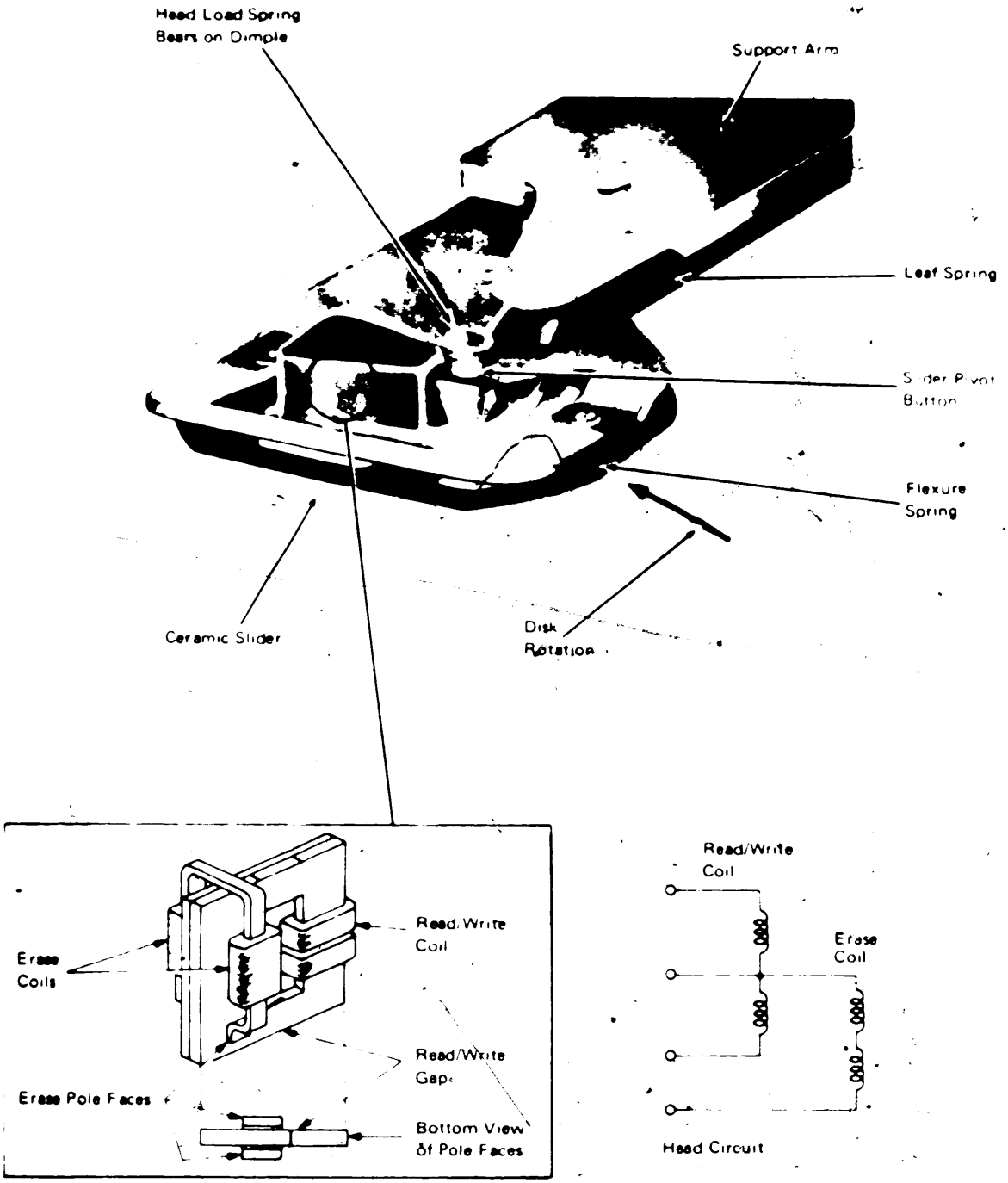


Figure 1-23 Read Write Head [07482A]

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 1-23), which transfers the head loading via the slider pivot 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.

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) Fr. C14 pulls on the head load cable to operate a linkage on the head load spring shafts (Figure 1-25) Fr. C15. 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.**

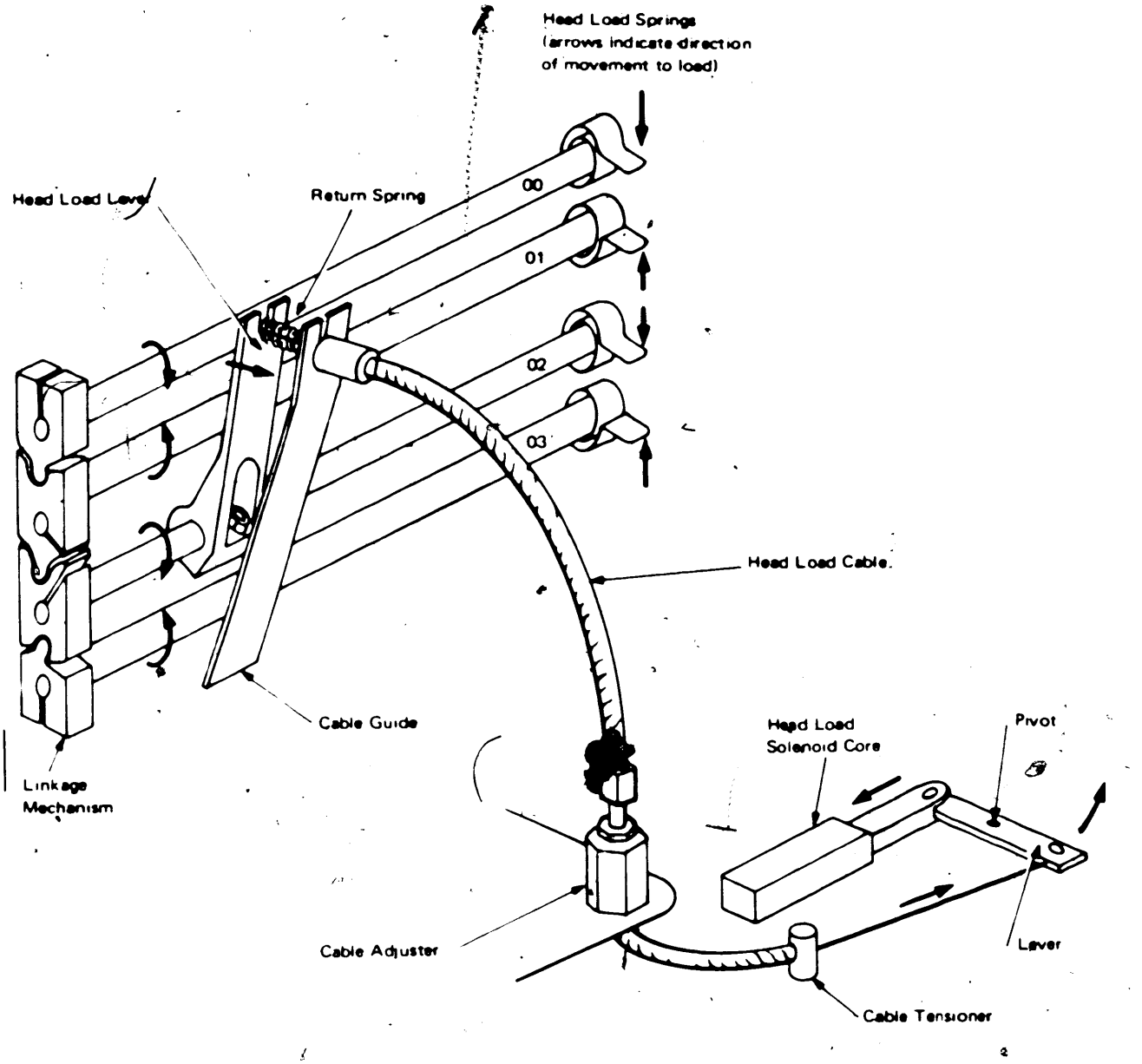


Figure 1-24 Head Load Linkage Principle [07484A]

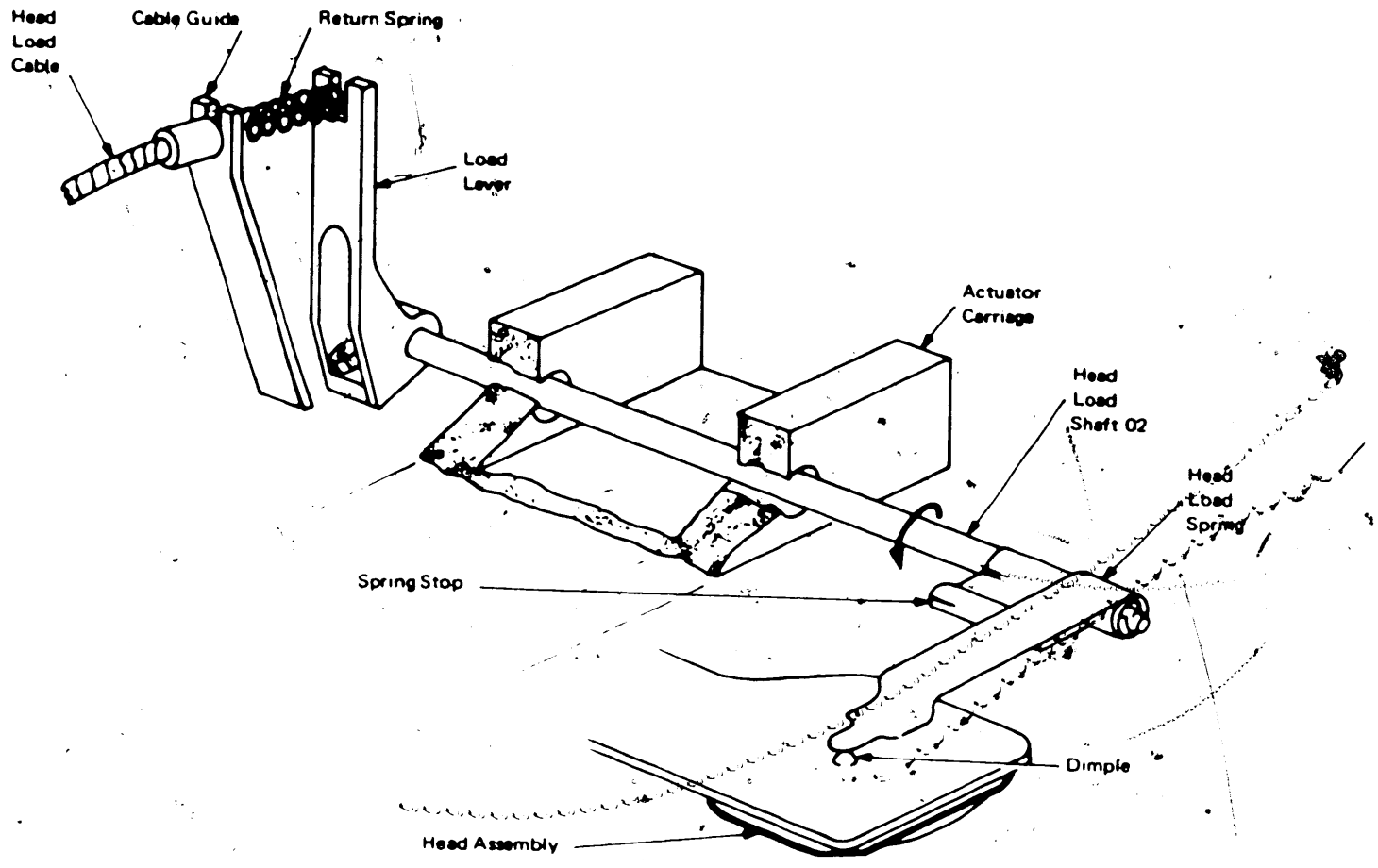


Figure 1-25. Head Load Shaft Operation [07485]

The head load solenoid assembly (Figure 1-26) Fr. C16 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) Fr. C16 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) Fr. C16 consists of a

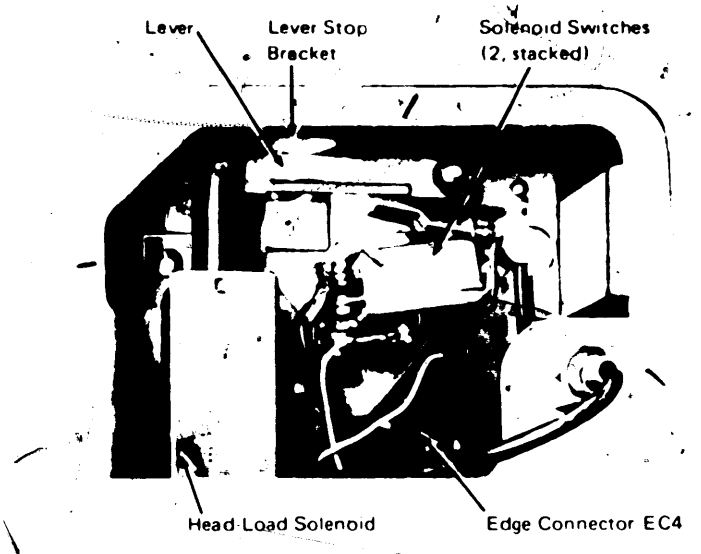


Figure 1-26. Head Load Solenoid Assembly [07486]

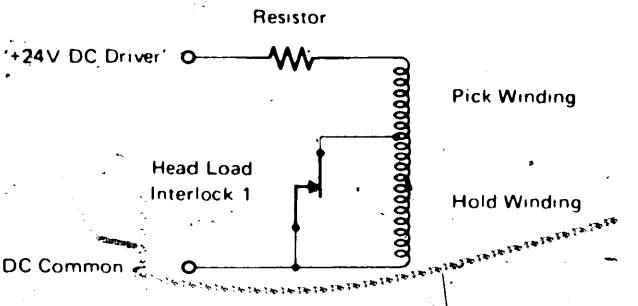


Figure 1-27. Head Load Solenoid Circuit [07487A]

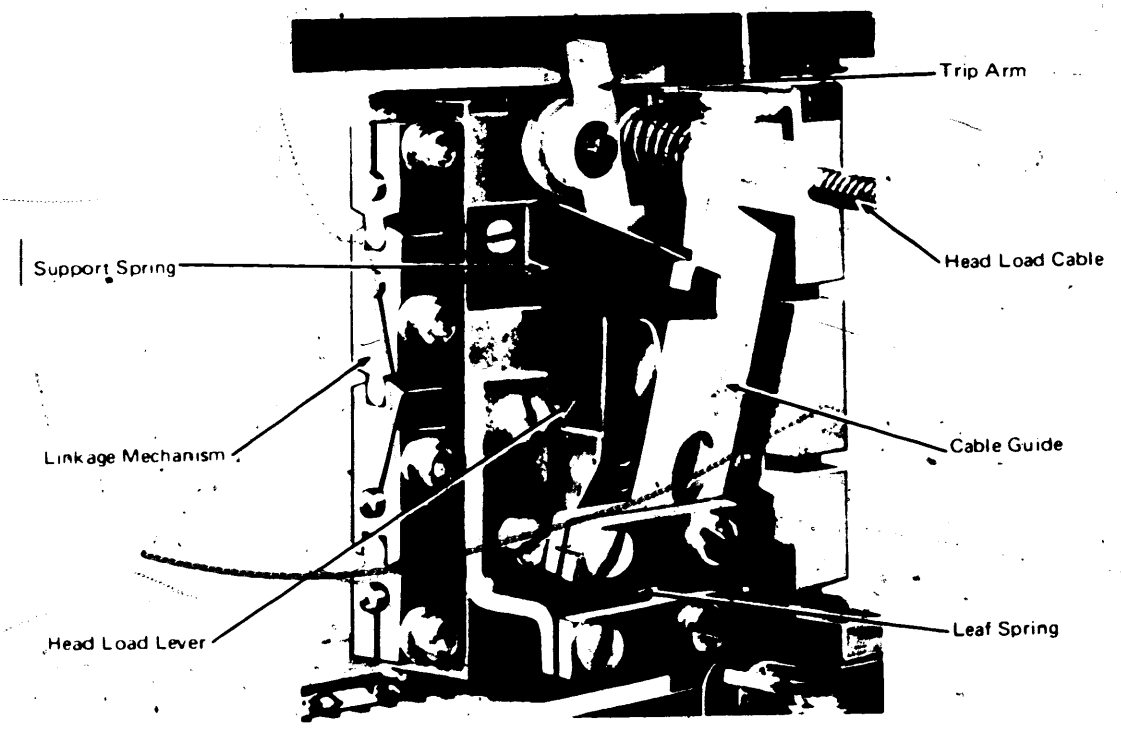


Figure 1-28. Knock-Off Mechanism [07488A]

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 rectified before the heads are reloaded. *Resetting the mechanism must only be performed be a CE.*

AC BOX

The ac box is mounted at the rear of the 5444 (see Figure 1-4) Fr. B13 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) Fr. B13 and contains the following:

1. Terminal block for the dc input supply from the using system.
2. Two relays: K2 (drive sequence) and K4 (head load relay).
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 Part 1, 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. Fr. D02**

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 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.

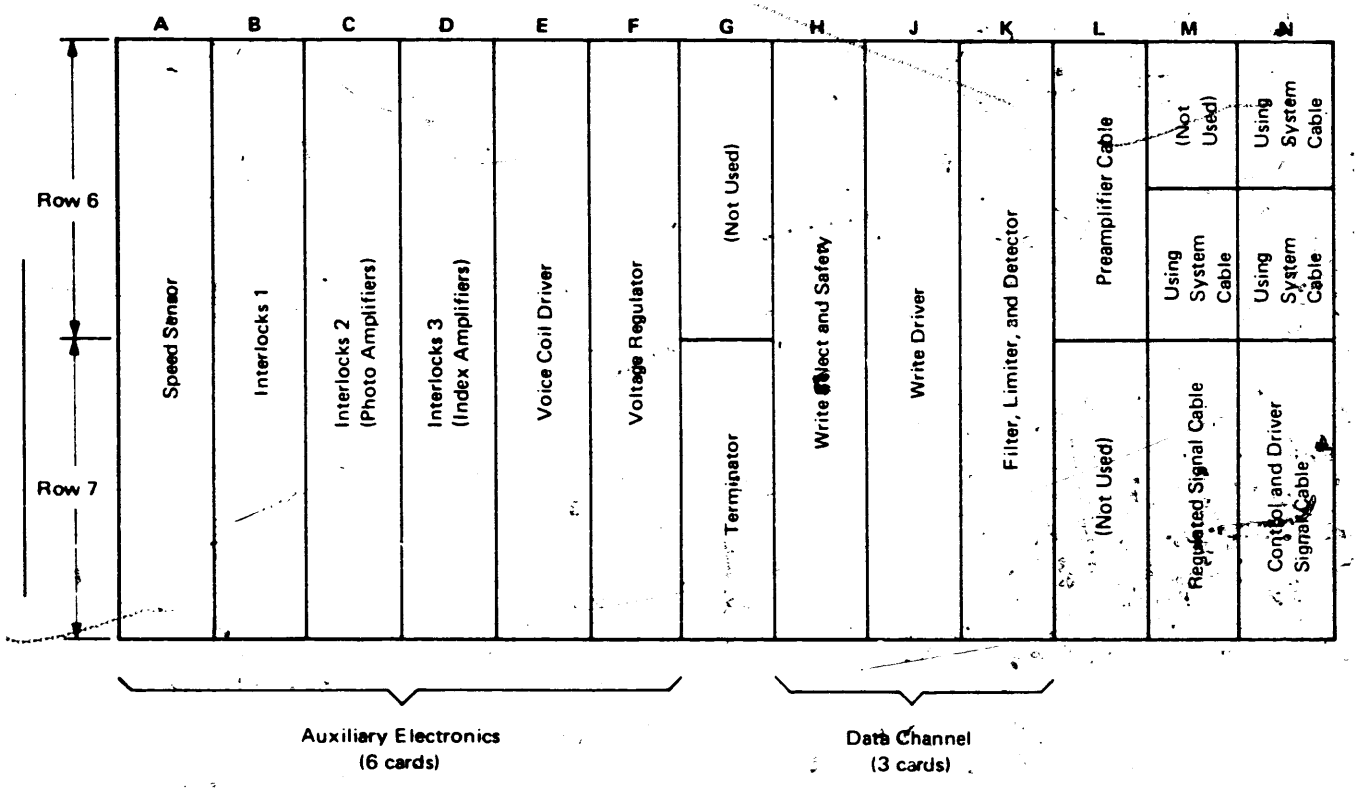


Figure 1-29. Logic Gate Card Layout (Card Side) [07489]

CONTINUED ON FRAME D01

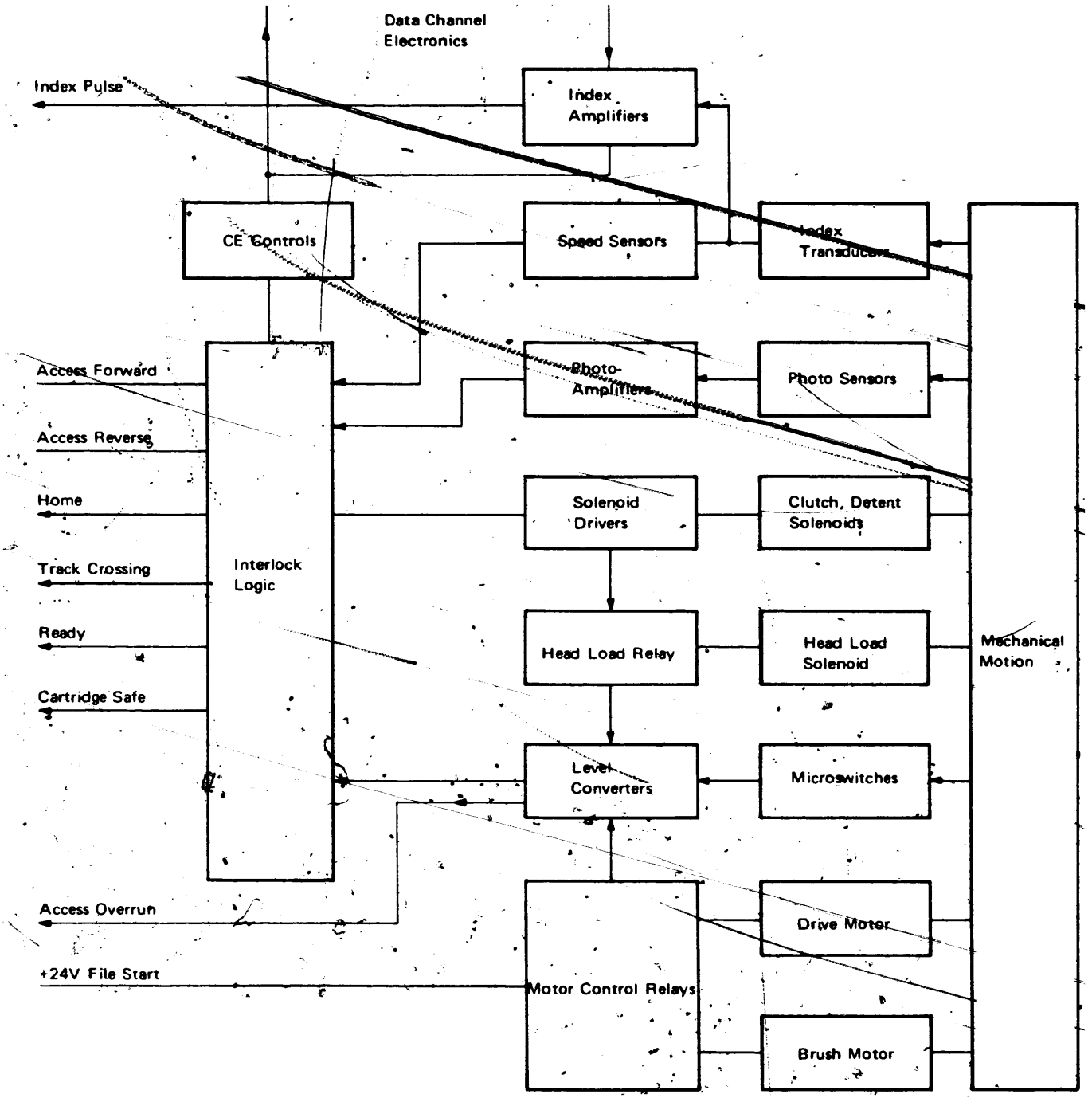


Figure 1-30. Auxiliary Electronics [07490]

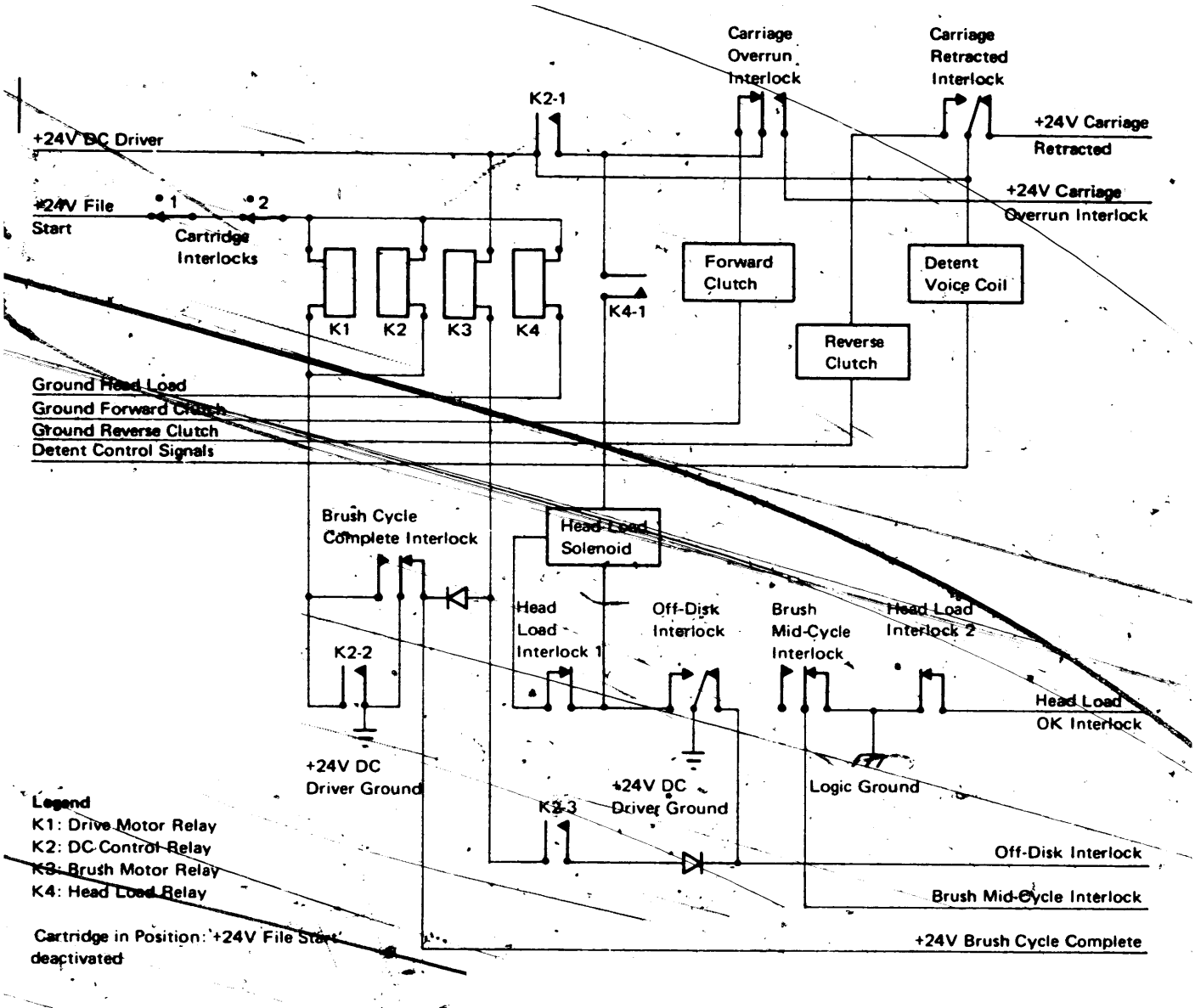


Figure 1-31. Interlock Switch Circuits [07491A]

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 or a slot cut into the drive spindle pulley (Figure 1-33); the nib is used on early (plastic) pulleys and the slot on late (metal) pulleys. For both transducers, changes in reluctance are detected as the slot or nib passes. One pulse is detected per revolution of the disks.

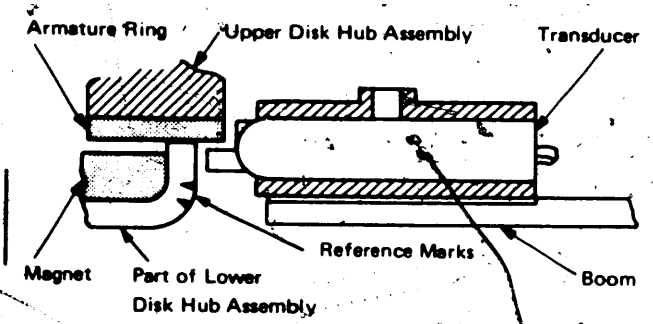


Figure 1-32. Upper Index Transducer [07492A]

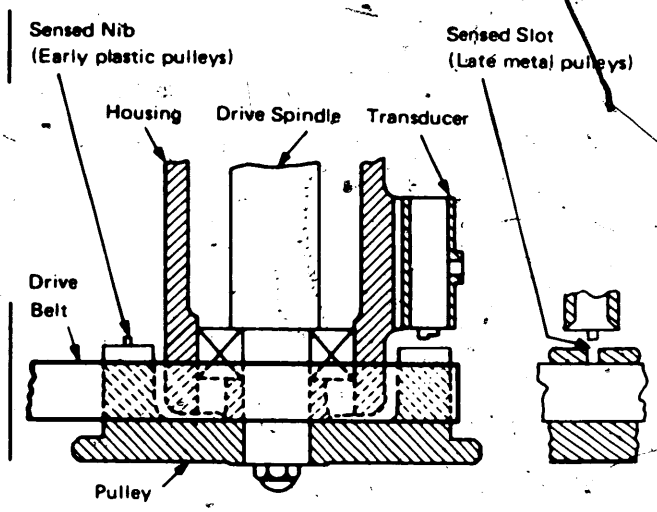


Figure 1-33. Lower Index Transducer [07493A]

The transducer output pulses are fed into two index amplifiers, one of which is selected by the 'upper 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 both transducers is also fed to the speed sensor circuits to monitor the disk speed.

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 001½, 011½, 021½, 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 and lamp are mounted on the actuator frame (see Figure 1-16). Illumination to the photocell is interrupted by two metal flags attached to the carriage (Figure 1-36): 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.

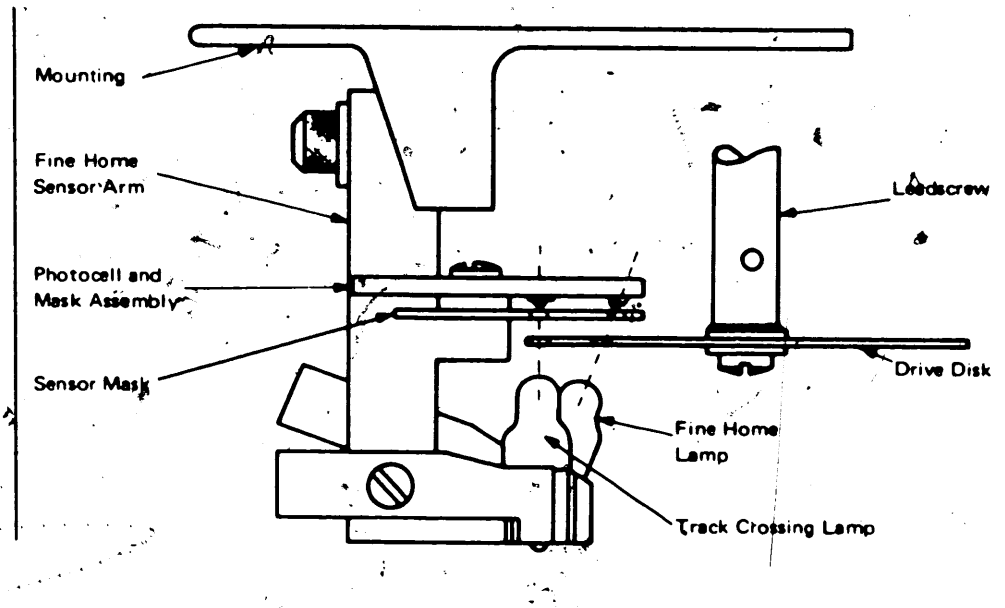


Figure 1-34. Track Crossing Sensor/Fine Home Sensor [07494A]

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 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'. 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.**

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.

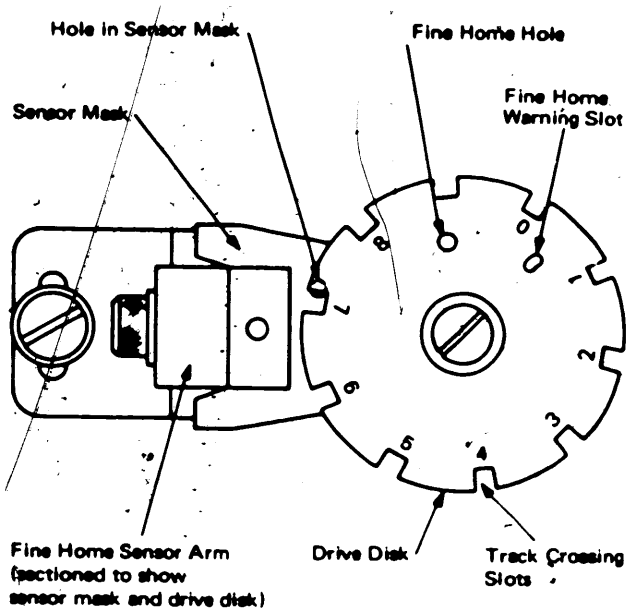


Figure 1-35. Drive Disk and Sensor Mask [07495A]

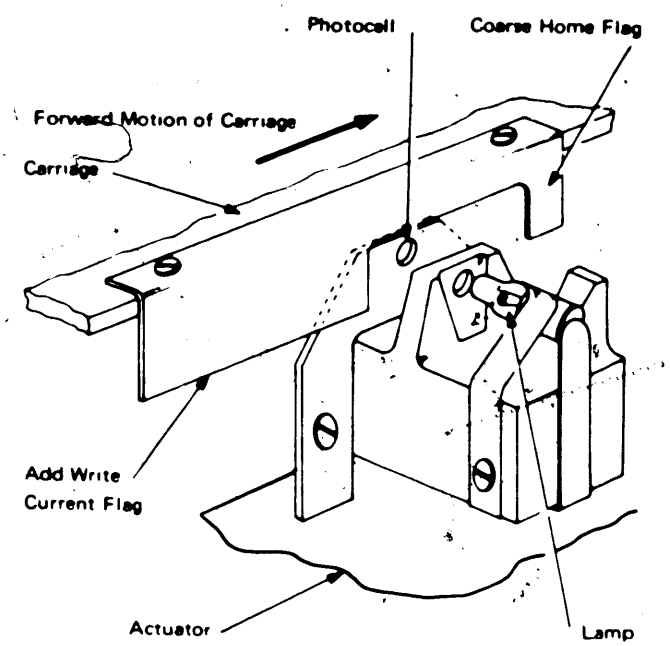


Figure 1-36. Carriage Photocell [07496]

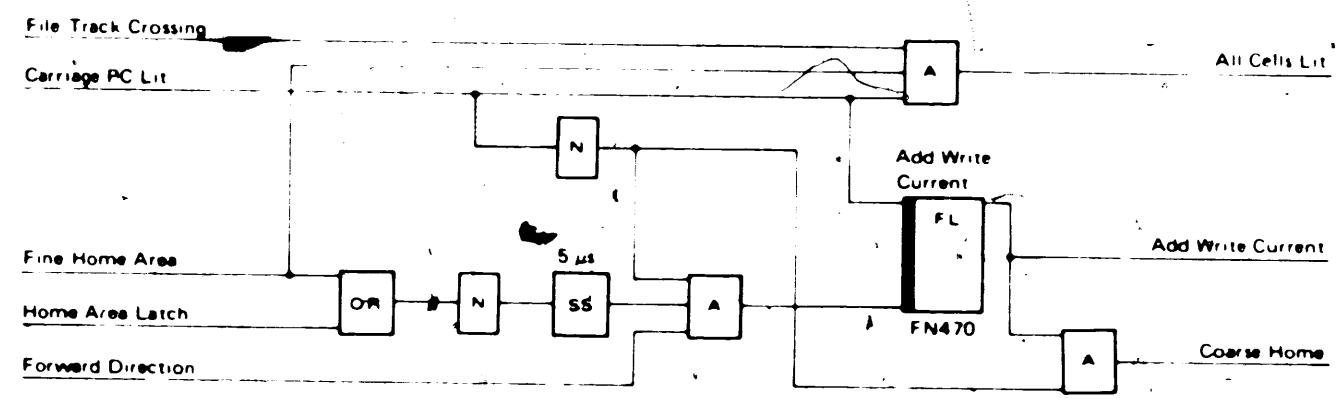


Figure 1-37. Carriage Photocell Signals [07497]

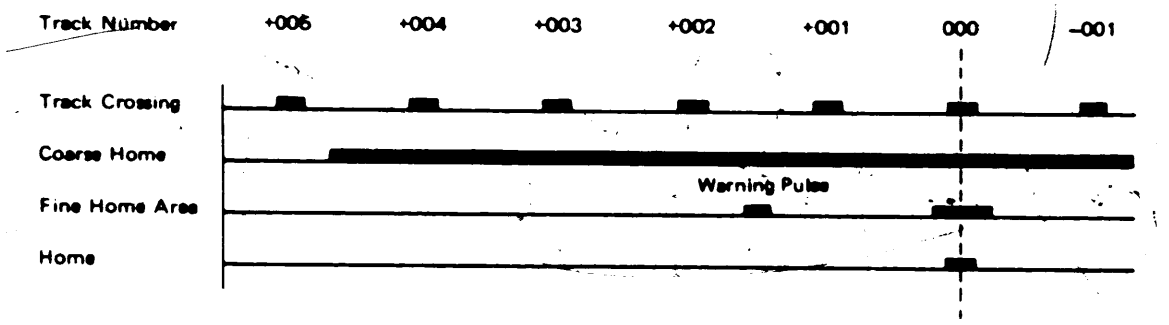


Figure 1-38. Track 000 Indication [07498]

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 13 SLT board (see Figure 1-29). The fourth card (matrix and preamplifier) is mounted in the preamplifier enclosure.

PRINCIPLES

OF

OPERATION

D08

3. Principles of Operation

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 13-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

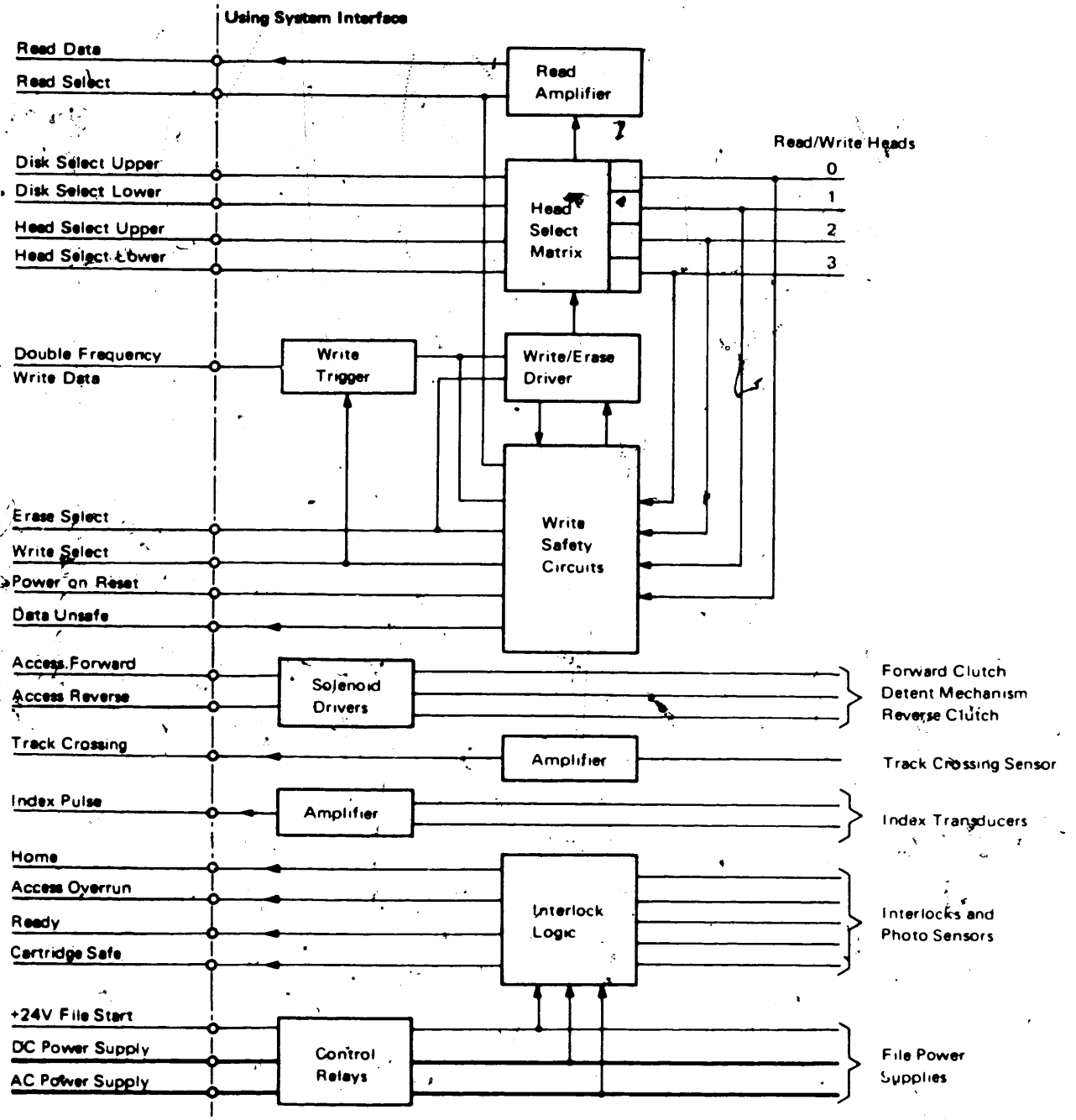


Figure 1-39. Data Flow and Control [07499]

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 under control of CE control panel. The 'write select' line is activated within 1μs 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.

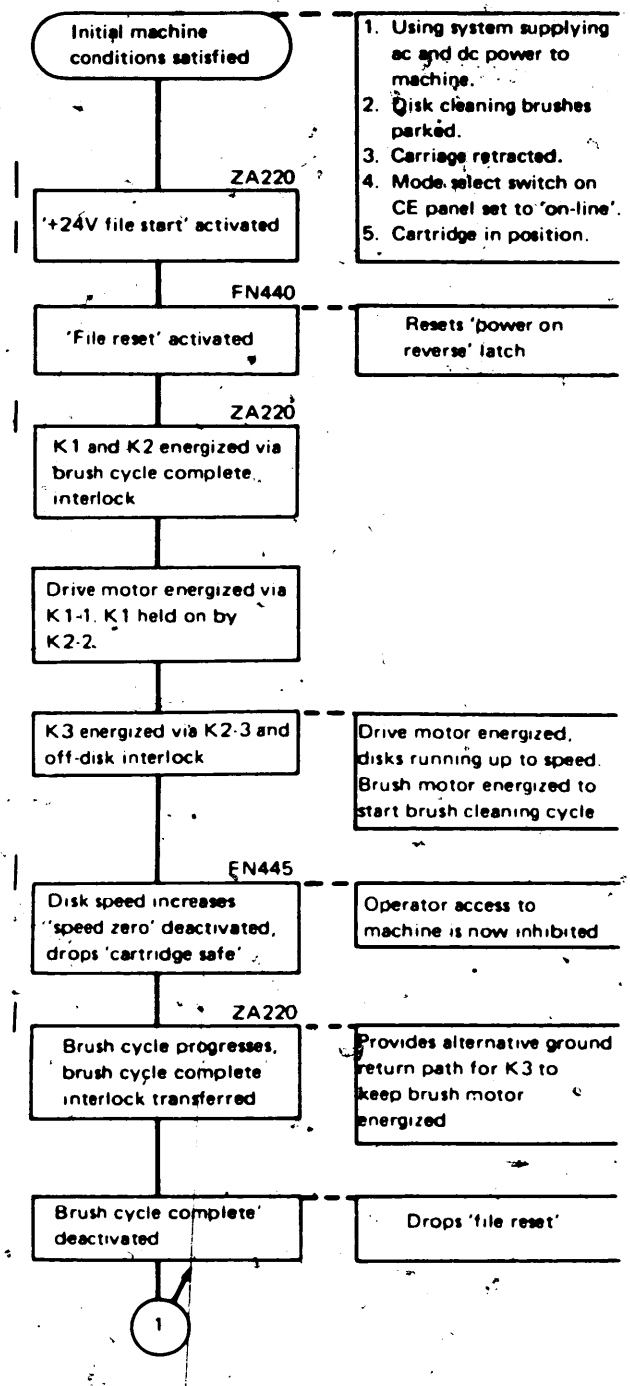
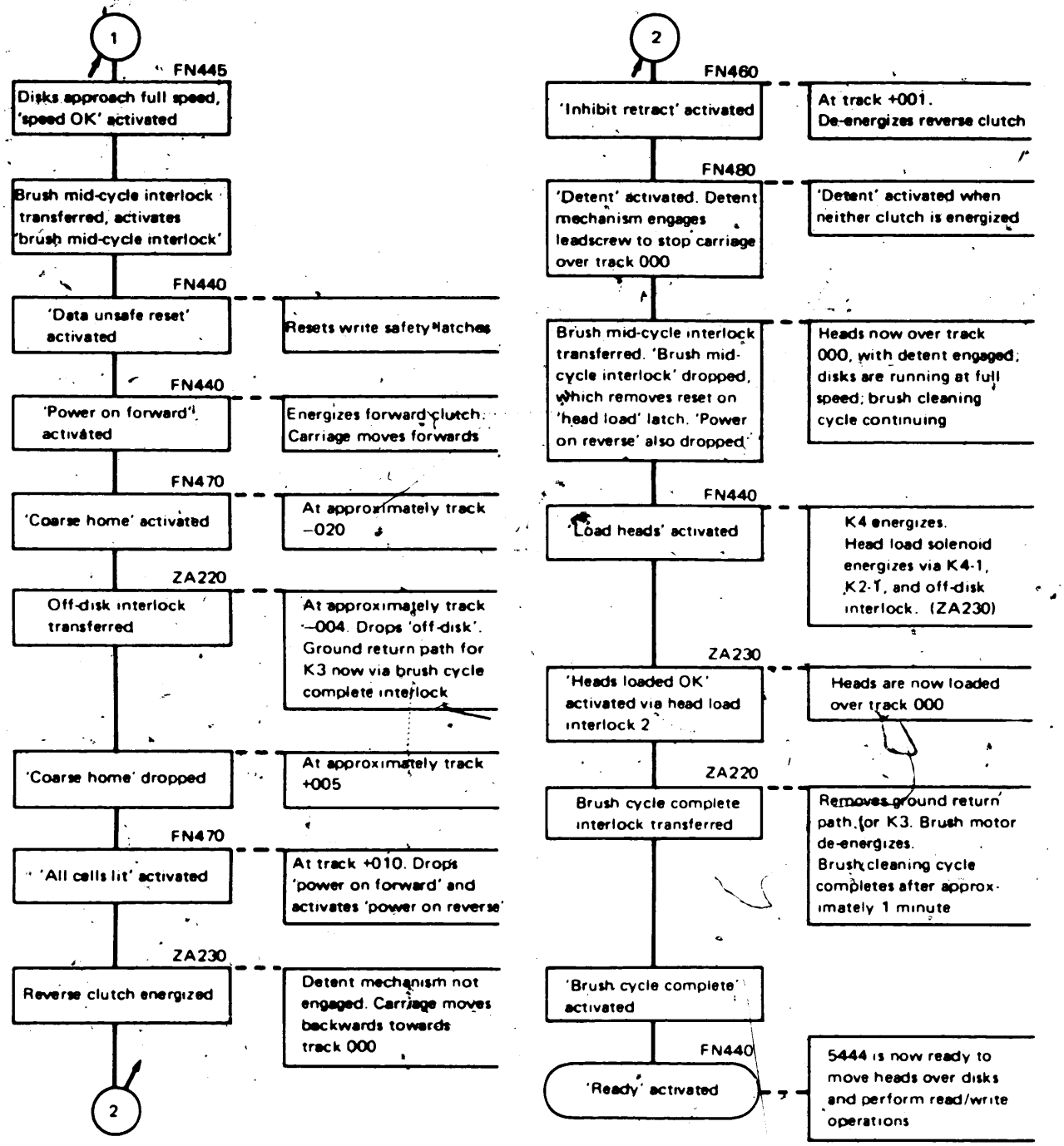


Figure 1-40. Start-Up Sequence - Flowchart [07500A]


1
FN445
Disks approach full speed, 'speed OK' activated
Brush mid-cycle interlock transferred, activates 'brush mid-cycle interlock'
FN440
'Data unsafe reset' activated
Resets write safety latches
FN440
'Power on forward' activated
Energizes forward clutch. Carriage moves forwards
FN470
'Coarse home' activated
At approximately track −020
ZA220
Off-disk interlock transferred
At approximately track −004. Drops 'off-disk'. Ground return path for K3 now via brush cycle complete interlock
'Coarse home' dropped
At approximately track +005
FN470
'All cells lit' activated
At track +010. Drops 'power on forward' and activates 'power on reverse'
ZA230
Reverse clutch energized
Detent mechanism not engaged. Carriage moves backwards towards track 000
2
2
FN460
'Inhibit retract' activated
At track +001. De-energizes reverse clutch
FN480
'Detent' activated. Detent mechanism engages leadscrew to stop carriage over track 000
'Detent' activated when neither clutch is energized
Brush mid-cycle interlock transferred. 'Brush mid-cycle interlock' dropped, which removes reset on 'head load' latch. 'Power on reverse' also dropped
Heads now over track 000, with detent engaged; disks are running at full speed; brush cleaning cycle continuing
FN440
'Load heads' activated
K4 energizes. Head load solenoid energizes via K4-1, K2-1, and off-disk interlock. (ZA230)
ZA230
'Heads loaded OK' activated via head load interlock 2
Heads are now loaded over track 000
ZA220
Brush cycle complete interlock transferred
Removes ground return path for K3. Brush motor de-energizes. Brush cleaning cycle completes after approximately 1 minute
'Brush cycle complete' activated
FN440
'Ready' activated
5444 is now ready to move heads over disks and perform read/write operations

07500A]

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. (See "Safety Circuits" under "Read/Write Operations".)

'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 'gated file start'.
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.**
- **The sequence is shown in Figure 1-40.** Fr. D11
- **Timing is given in Figure 1-41.**

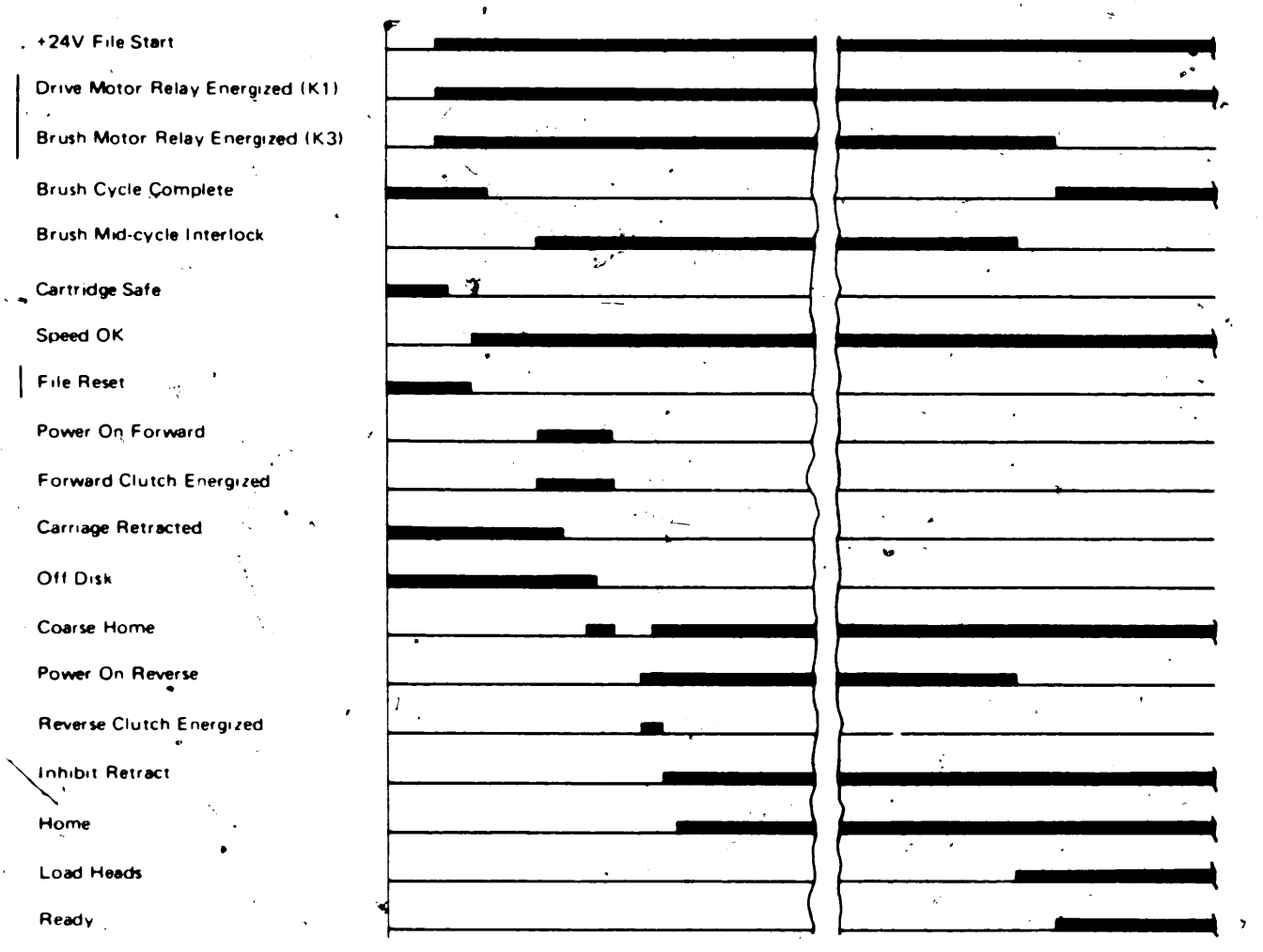
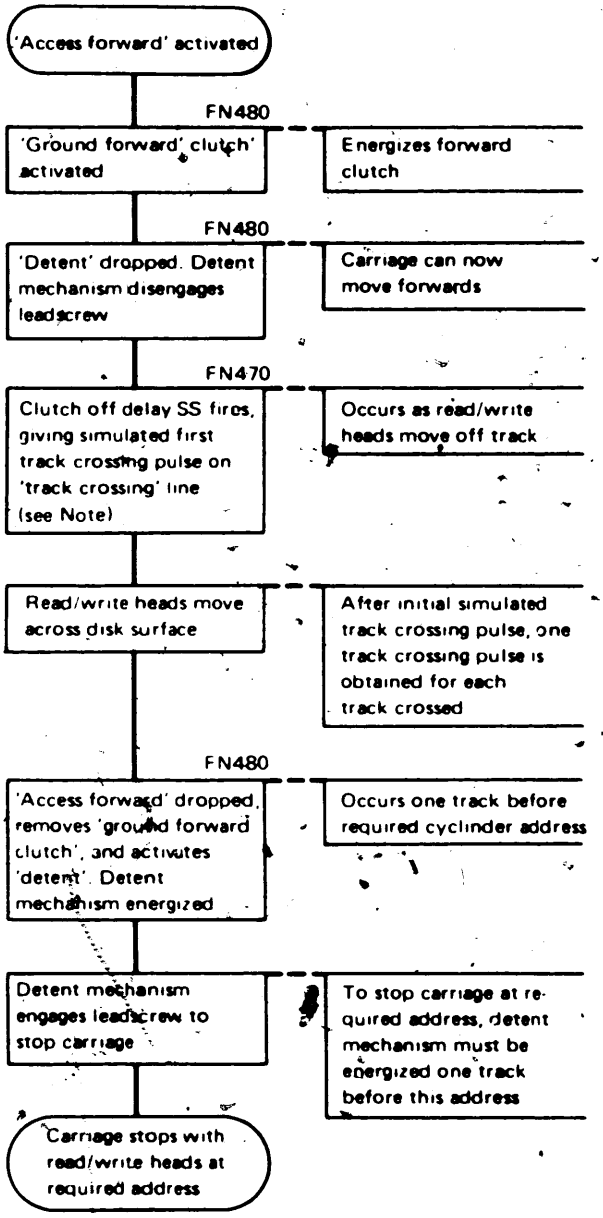


Figure 1-41. Start-Up Sequence Timing [07502A]



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 [07503A]

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'.

'Access Forward'

- Heads move towards center of disk.
- Sequence is given in Figure 1-42.
- Timing is given in Figure 1-43. Fr. D16
- Derivation of clutch and control signals is shown in Figures 1-44 and 1-45. Fr. D17

Single Track Accessing

- The sequence is shown in Figure 1-46. Fr. D17
- See Figures 1-43, 1-44, and 1-45 Fr. D17 for timing and logic.

'Access Reverse'

- Heads move away from center of disk.
- 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

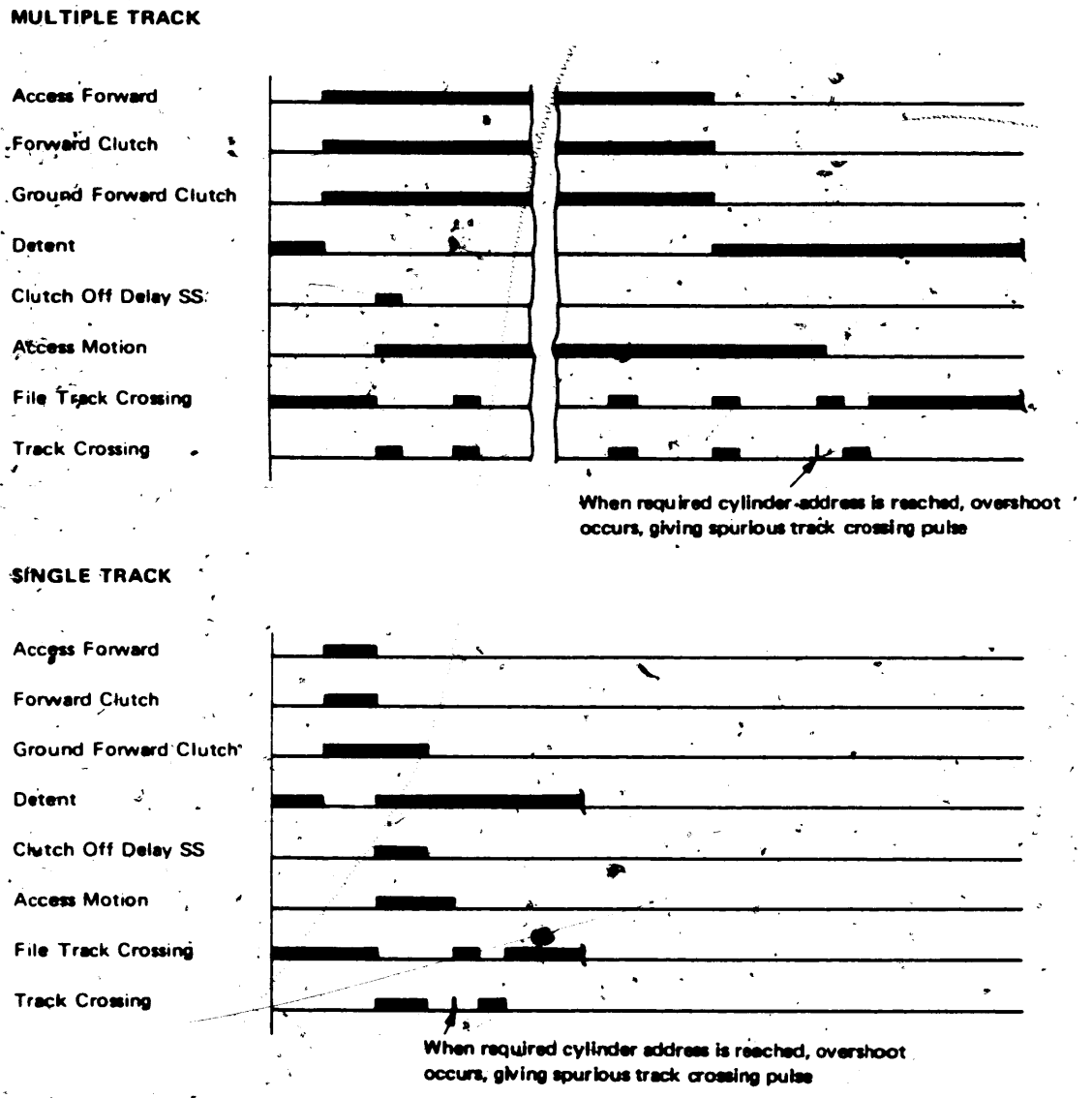


Figure 1-43. Head Forward Operation – Timing [07504]

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.

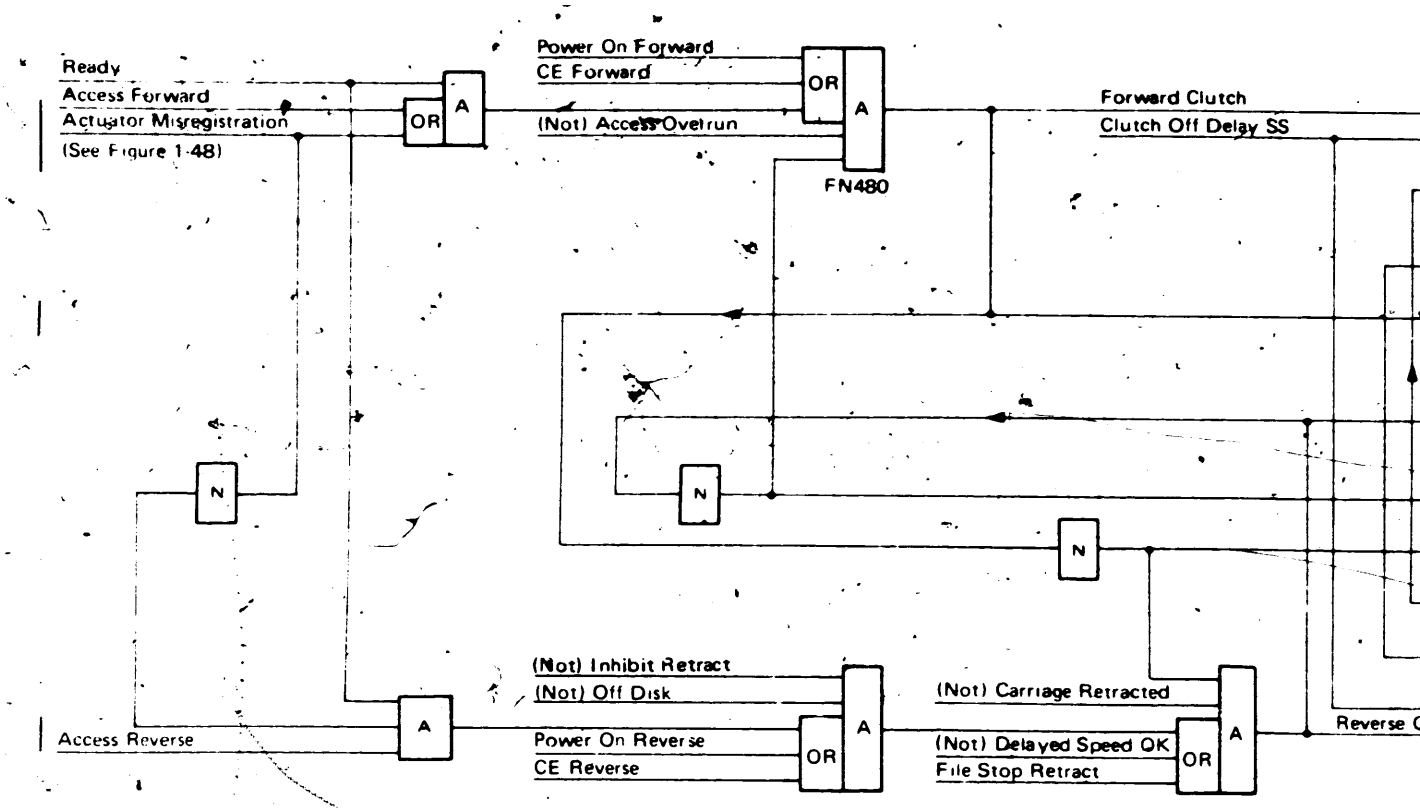


Figure 1-44. Clutch and Detent Signals [07505A]

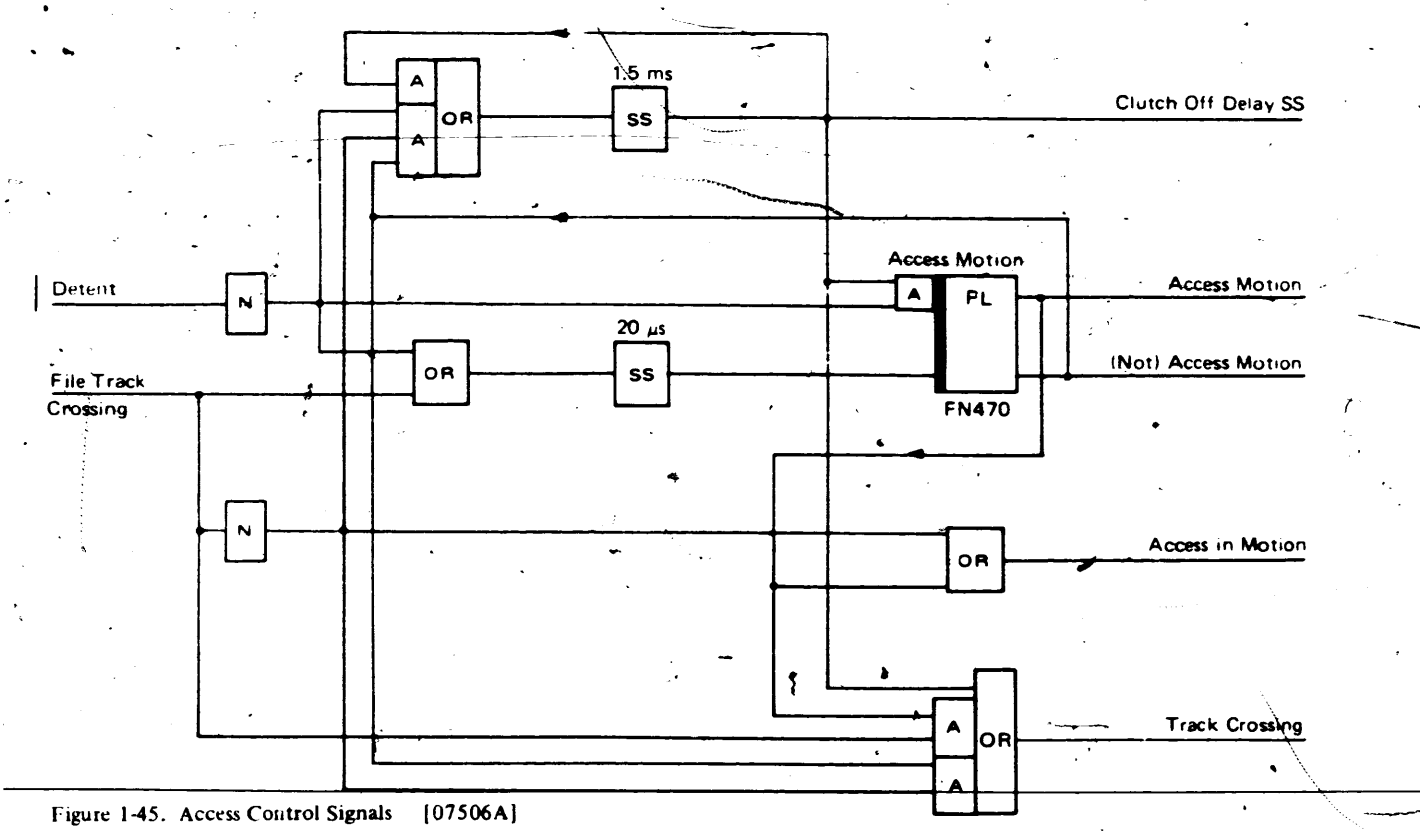
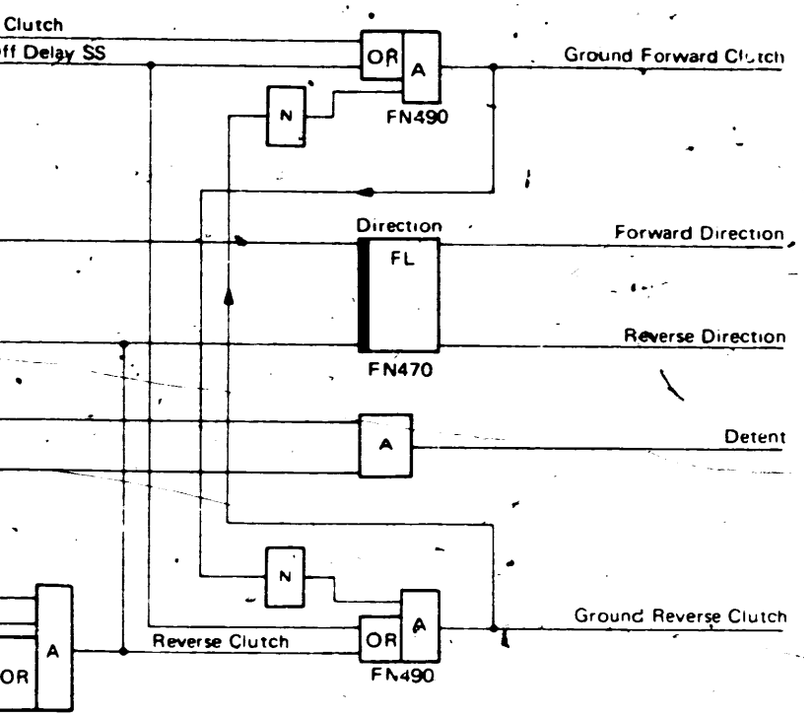


Figure 1-45. Access Control Signals [07506A]



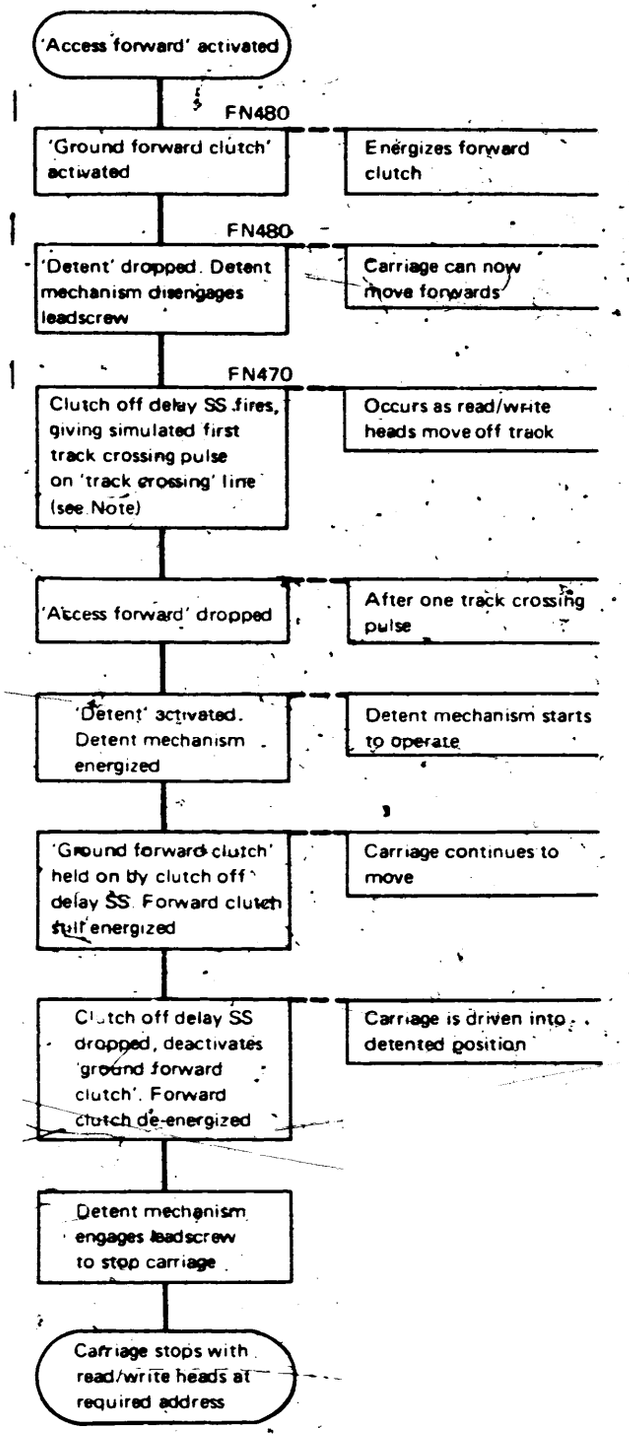
Off Delay SS

ccess Motion

ccess Motion

ess in Motion

rack Crossing



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 [07507A]

CONTINUED ON FRAME E01

Recalibration After Wrong Track Address

From Tracks 002 to 202: When 'access reverse' is activated, the carriage retracts towards track 000. At approximately track 001½, the fine home area warning pulse occurs, setting the 'home area' latch (Figure 1-47). Fr. E02 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). Fr. D17 ('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 Fr. E02 shows the head movement error logic.**

Between Tracks −000½ 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 'actuator misregistration' latch. 'Actuator misregistration' inhibits 'access reverse' and activates 'ground forward clutch', to move the carriage forwards until the 'actuator misregistration' latch is reset by 'carriage pc lit' at approximately track +005. 'Actuator 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 'actuator 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. The 'access overrun' signal is then sent back to the file attachment, which identifies a seek check. The program can then cause a recalibration to 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 Fr. E03 shows the CE control logic.**

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). Fr. D17

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

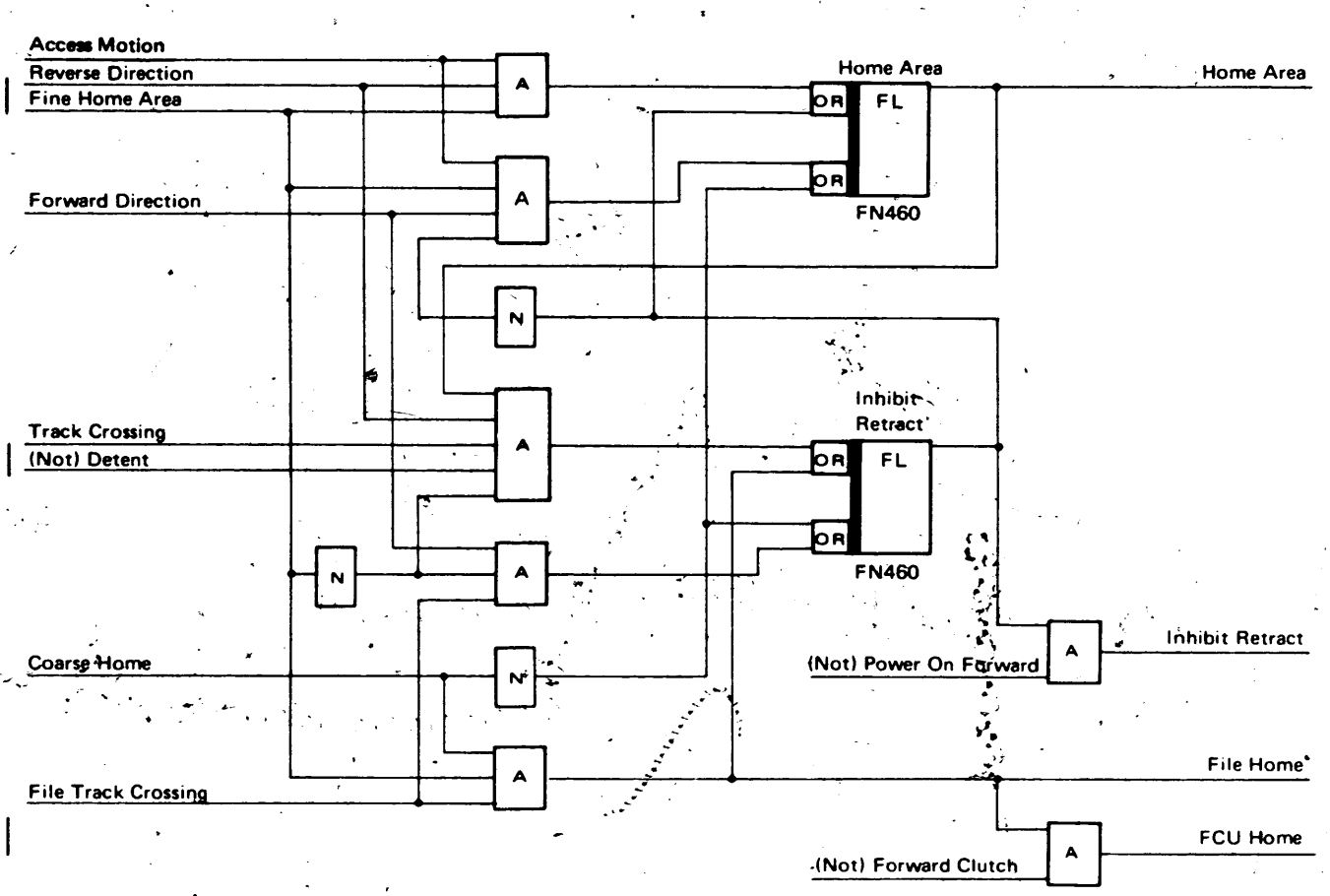


Figure 1-47. Home Detection Logic [07508A]

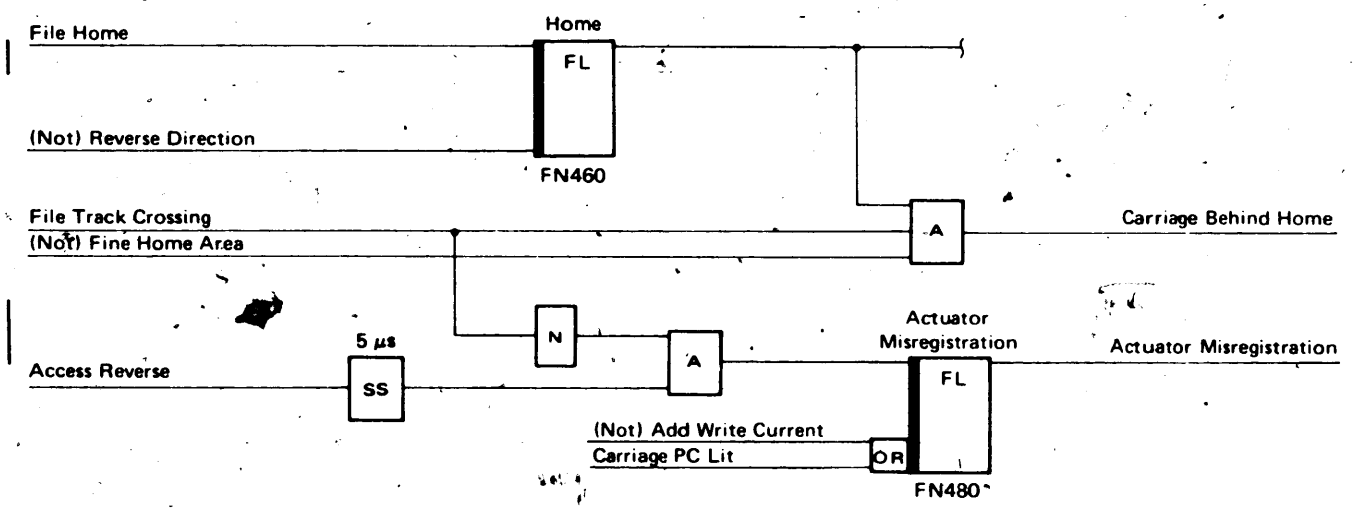


Figure 1-48. Head Movement Error Logic [07509A]

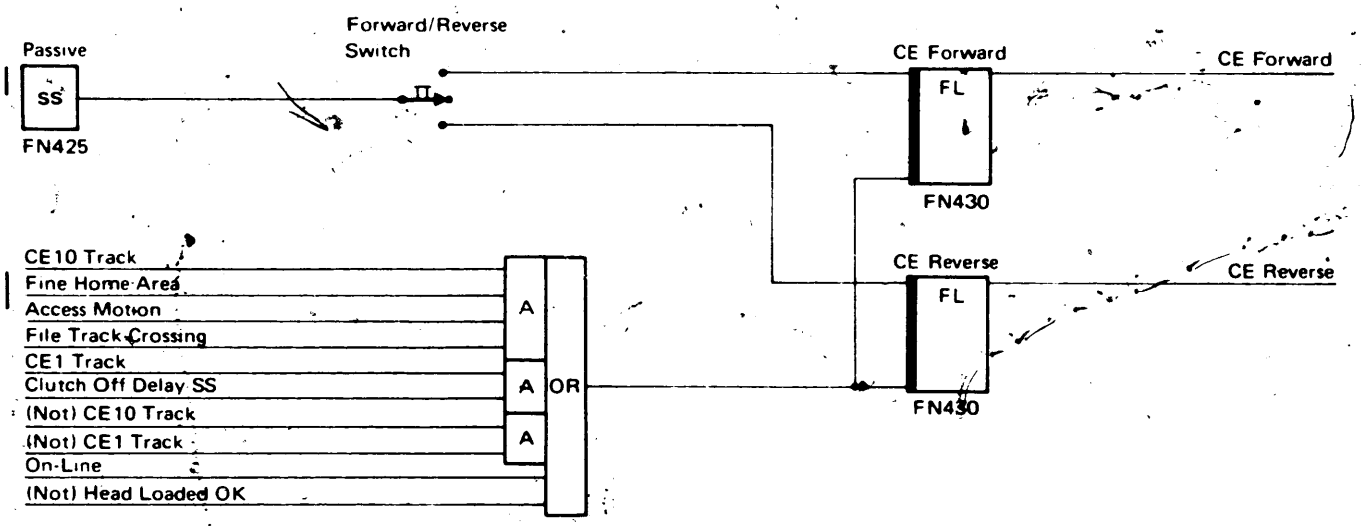


Figure 1-49. CE Control Logic [07510A]

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. Fr. E04**
- **The machine stop logic and timing are given in Figures 1-51 and 1-52. Fr. E05**
- **See Figure 1-47 Fr. E02 for home detection logic.**

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.

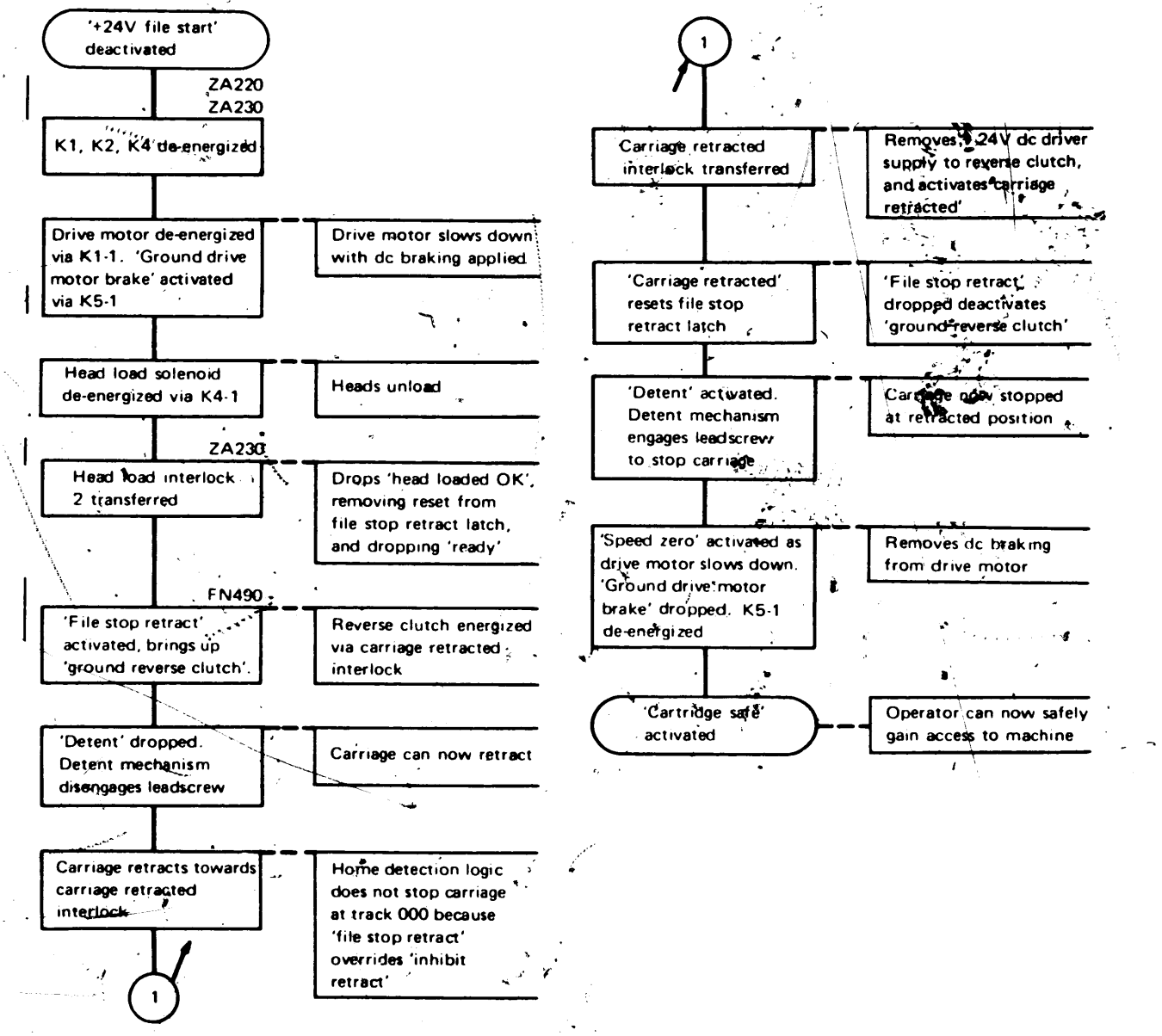


Figure 1-50. Machine Stop Sequence [07511A]

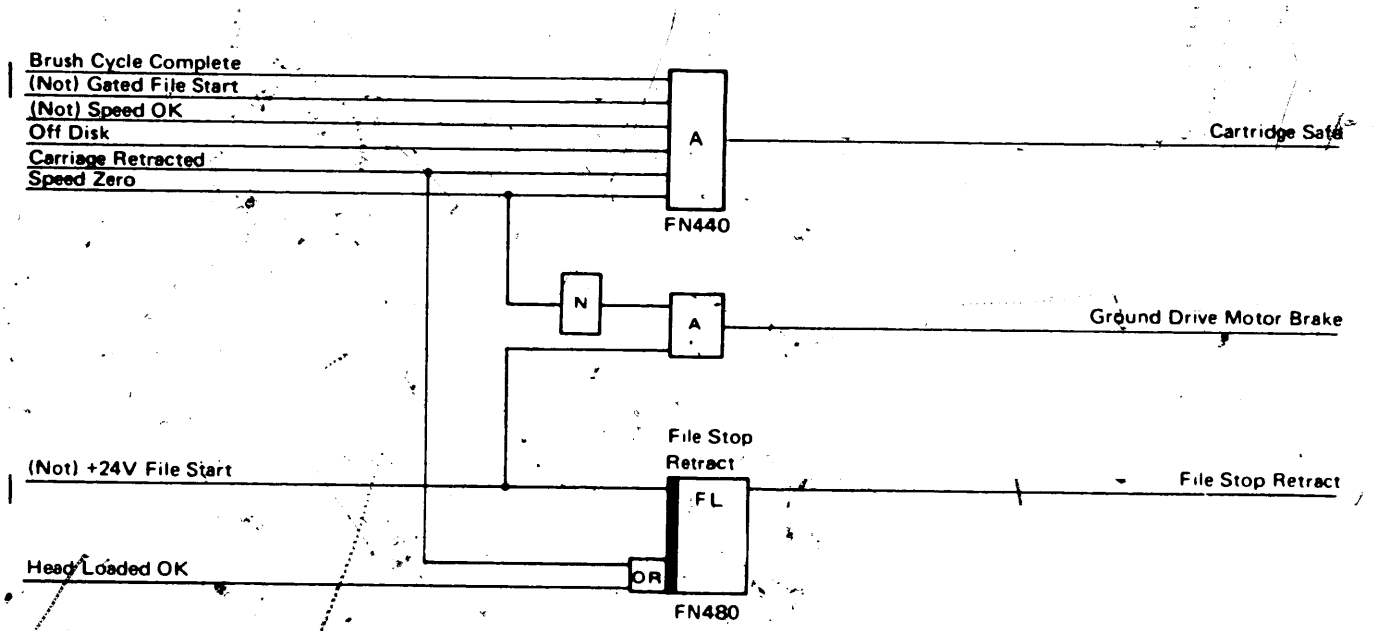


Figure 1-51. Machine Stop Logic [07512A]

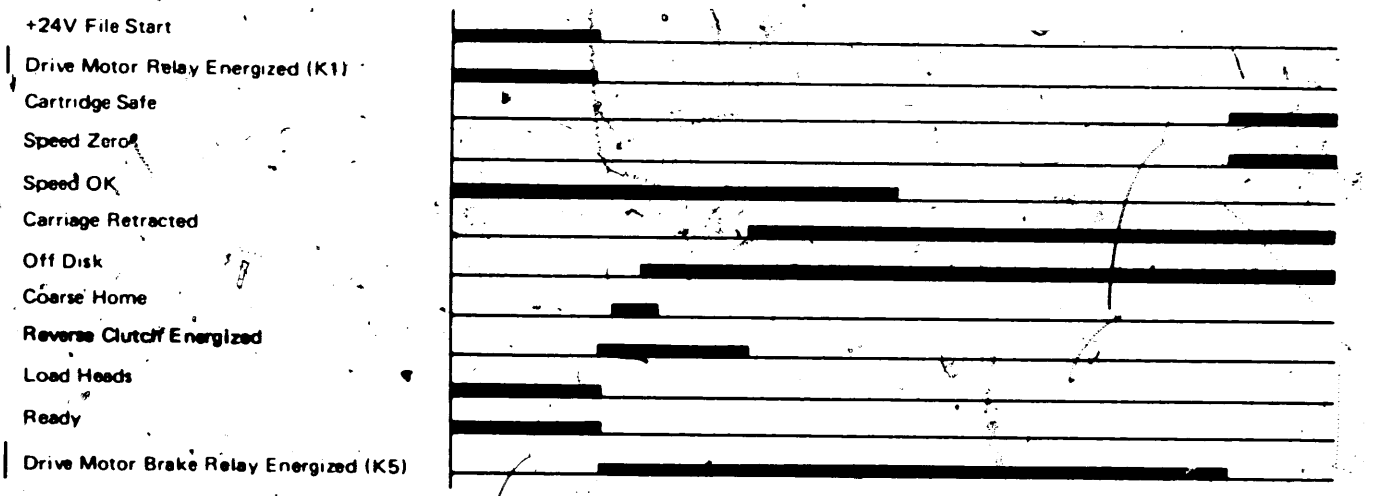


Figure 1-52. Machine Stop Timing [07513A]

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).

The recording device is a read/write head, diagrammatically represented in Figure 1-54. Fr. E07 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). Fr. E07

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. Fr. E08

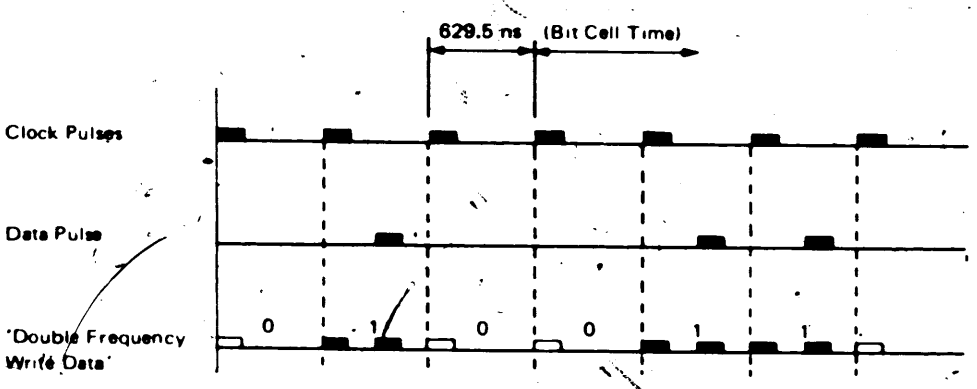


Figure 1-53. Derivation of Composite Write Signal [07514A]

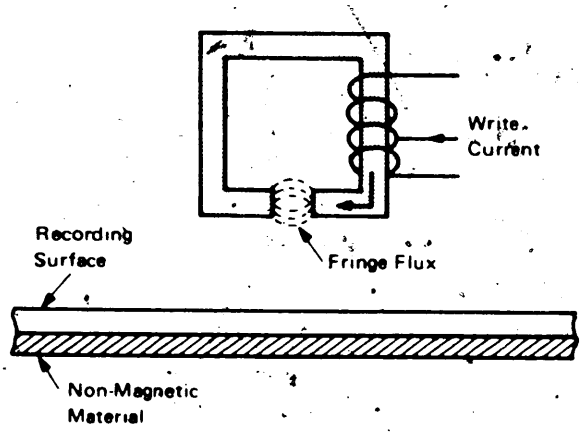


Figure 1-54. Basic Read/Write Head [07515]

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.

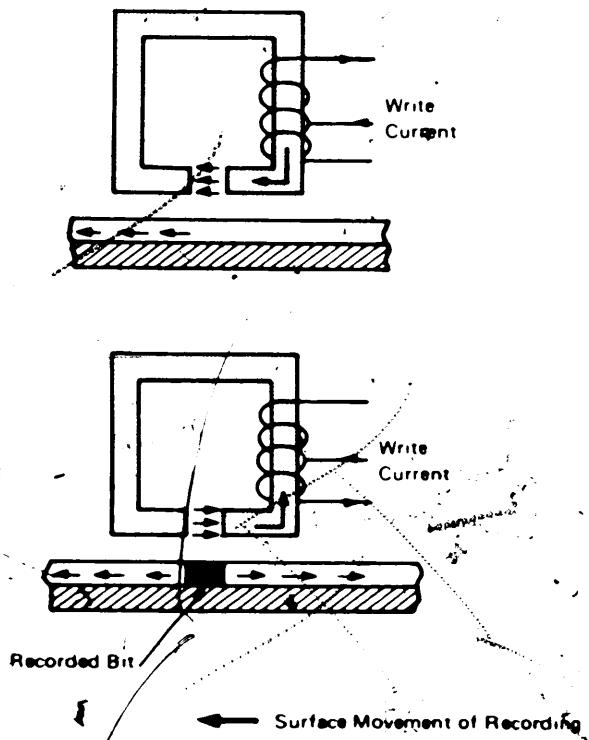


Figure 1-55. Horizontal Recording [07516]

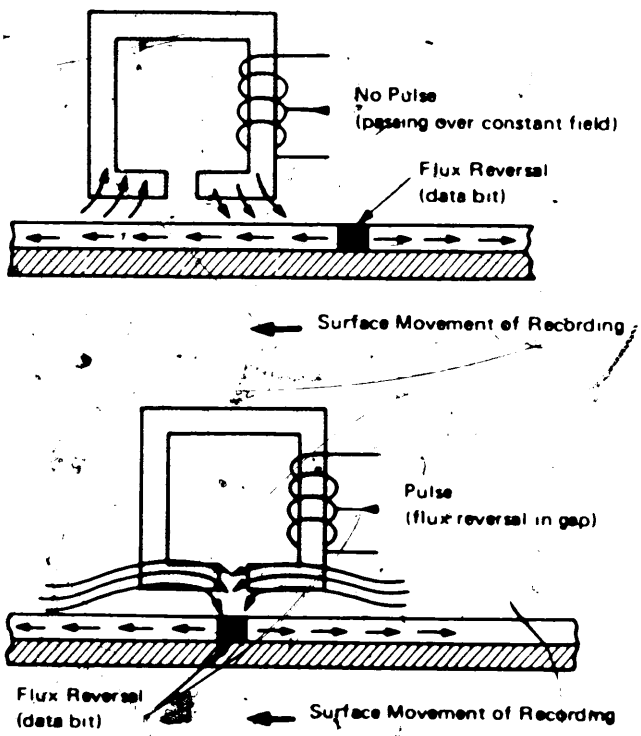


Figure 1-56. Horizontal Reading [07517]

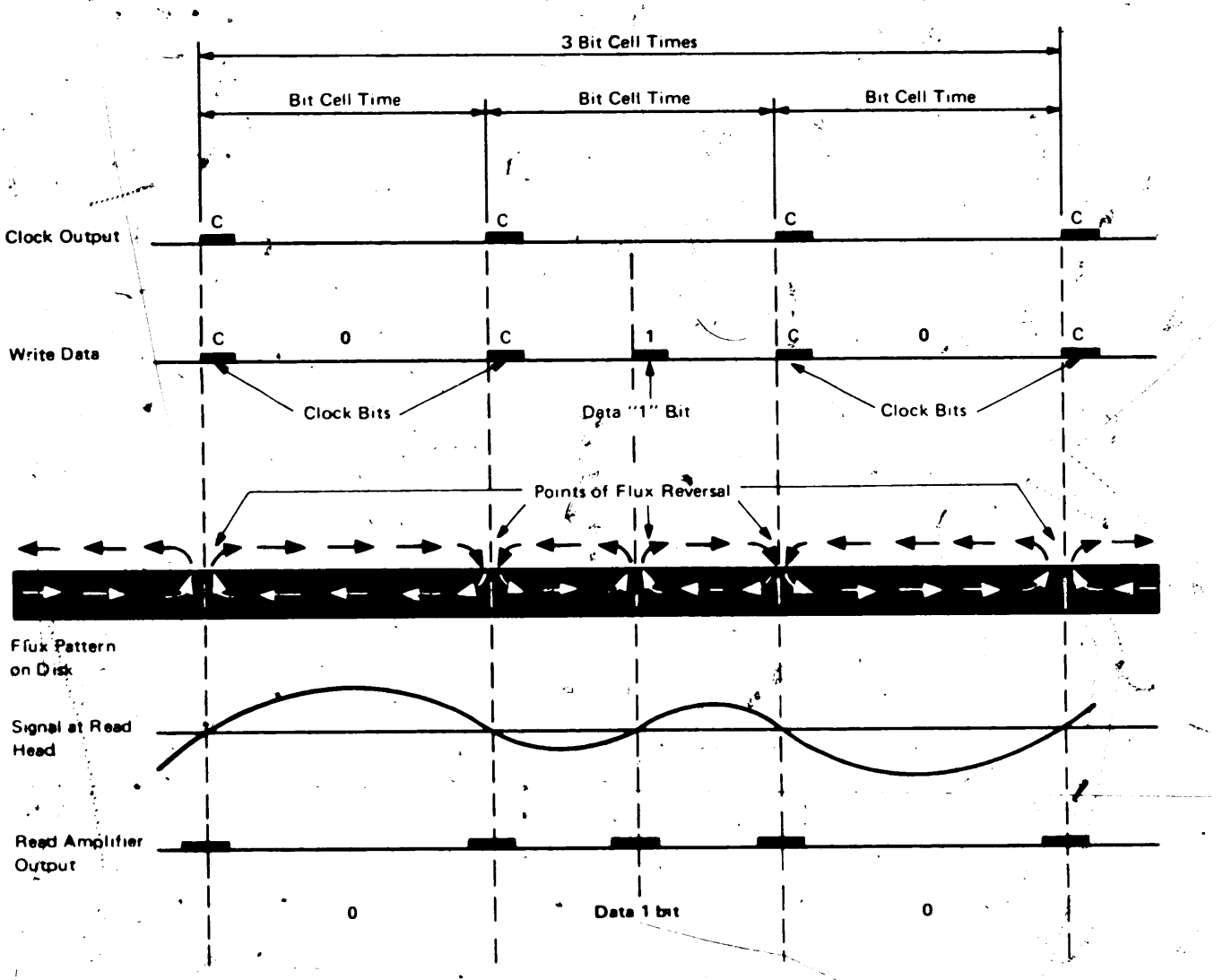
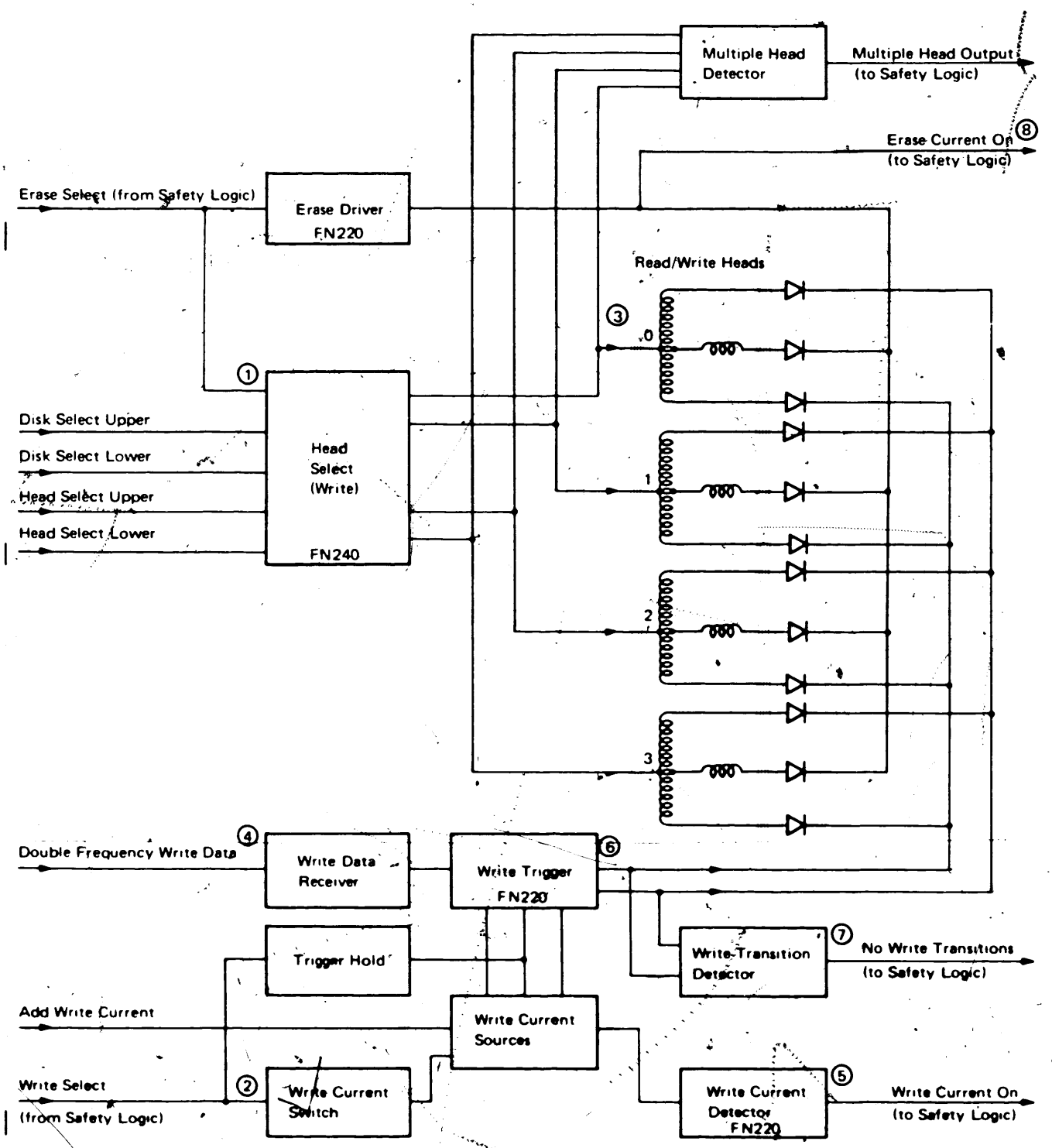
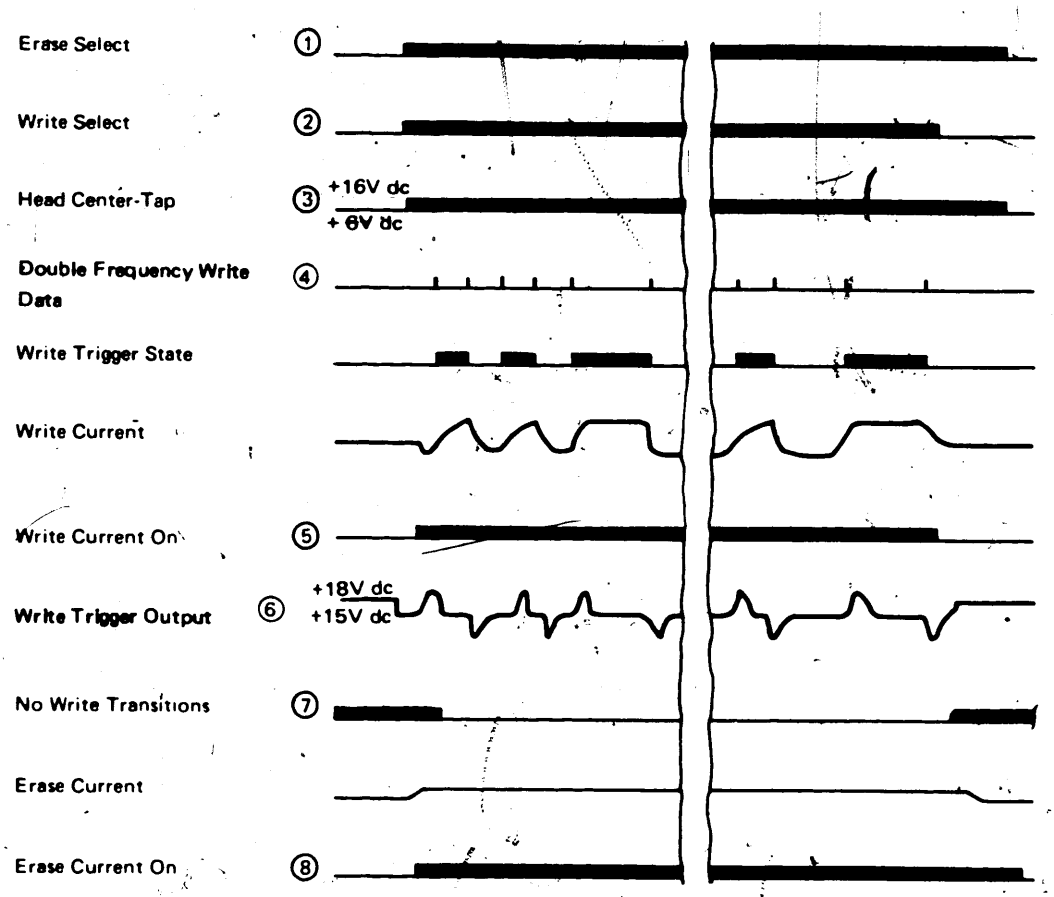


Figure 1-57. Double Frequency Recording - Flux and Pulse Relationship [07518]



Note: Circled numbers refer to Write Circuit waveforms (Figure 1-5B)

Figure 1-5B. Write Circuit – Logic [07519A]



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.

Fr. E09

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:

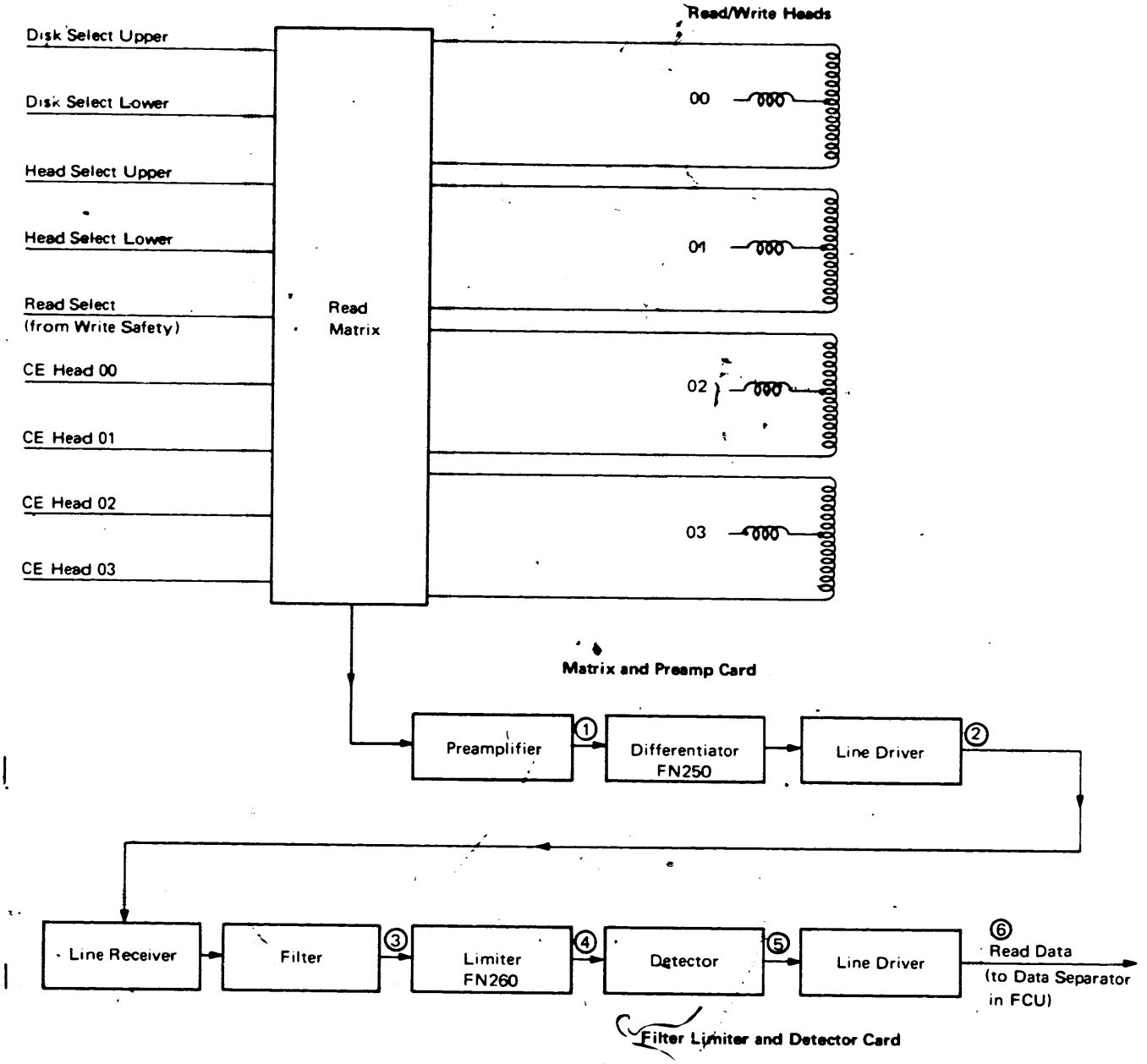
1. 'Write select' activated, with 'erase current on' dropped.
2. 'Write select' dropped, with 'erase current on' activated.

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.

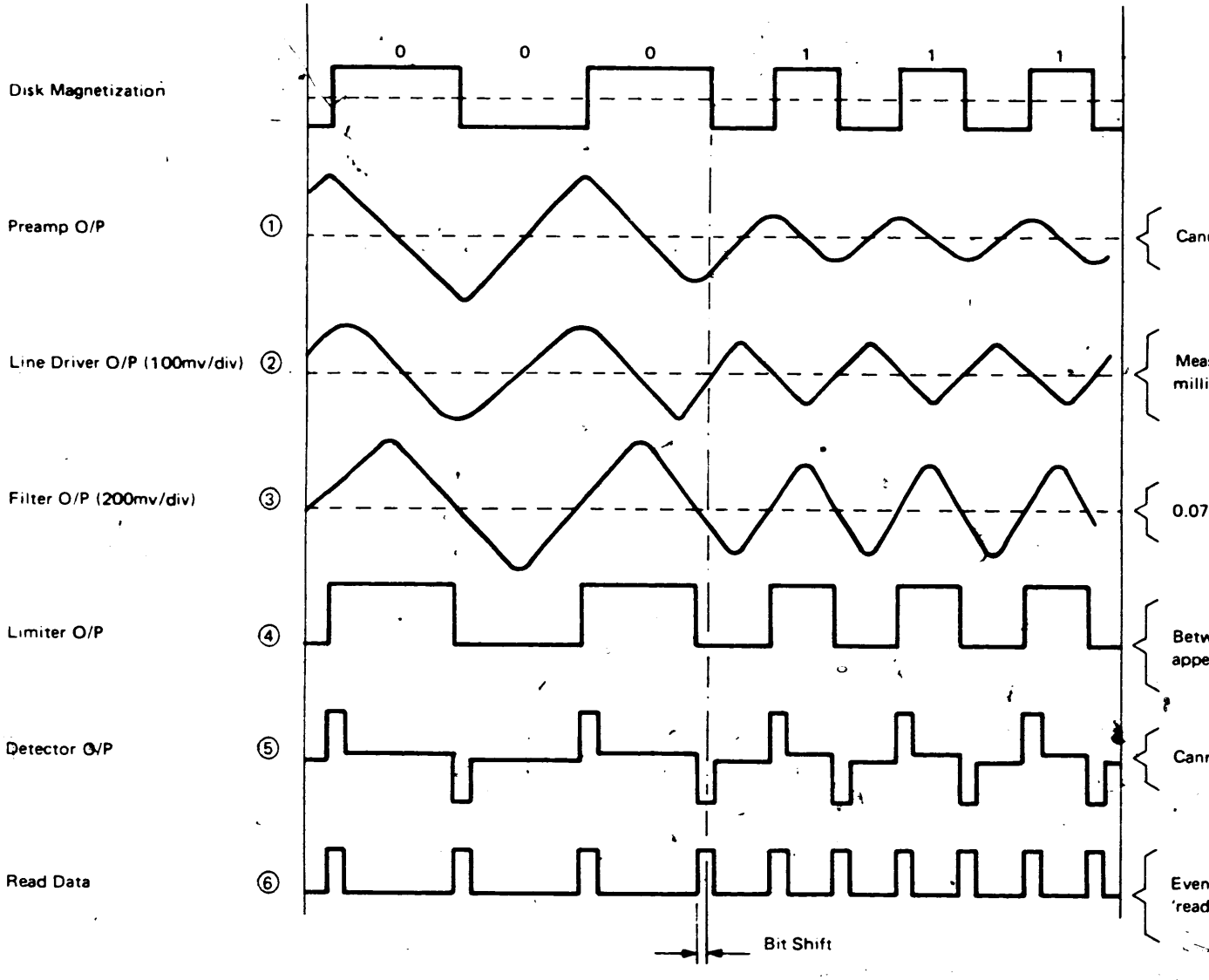
The latches are reset on machine start up, the line 'brush midcycle interlock' raising 'data unsafe reset'. If the unsafe condition is removed, read/write operations can resume.

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



Note: Circled numbers refer to Read Circuit waveforms (Figure 1-61) Fr. E13

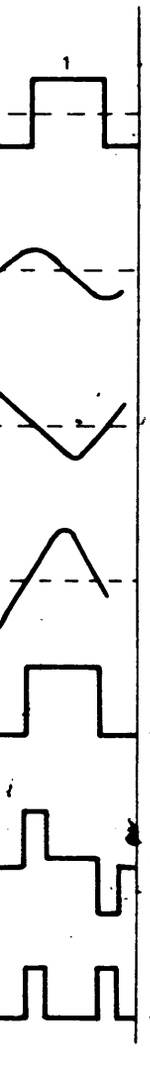
Figure 1-60. Read Circuit – Logic [07521A]



Notes:

1. Waveform numbers refer to read circuits. See Figure 1-60. Fr. E12
2. Voltage amplitude values are differential.

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



Cannot be scoped.

Measured in millivolts and may vary between 20 and 300 millivolts peak to peak.

0.070 to 1.75 Volts at filter output.

Between 3.9 and 4.3 Volts peak to peak. Random noise appears with no signal.

Cannot be scoped.

Even with no signal random noise pulses appear on the 'read data' line.

CONTINUED ON
FRAME E16

POWER

AND

COOLING

E16

5. Power and Cooling

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. Fr. E18**
- **Separate ac and dc logic grounds are provided.**

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. The drive motor and brush motor are also ac grounded. AC ground points must not be allowed to contact the 5444 base casting (dc logic ground) or else read write errors may be caused.

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.

E17

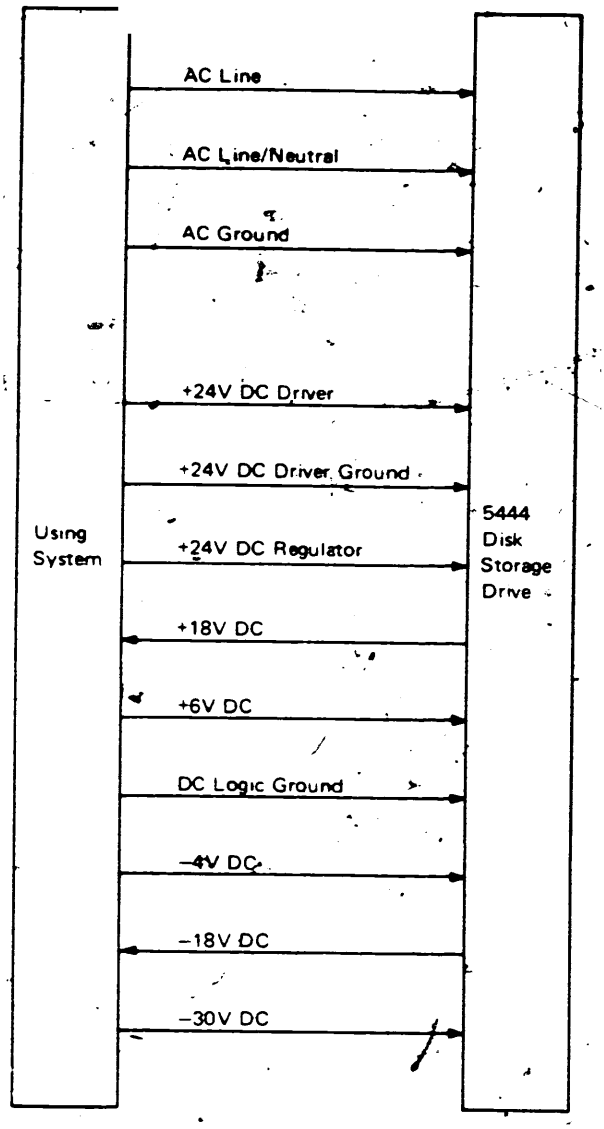


Figure 1-62. Input Power Lines [07523]

CONTINUED ON FRAME 801 CARD 1-2