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Field Engineering
Theory of Operation
(Manual of Instruction

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Single Disk Storage
(Serial Numbers 00001 through 39999)

PREFACE

This manual describes the mechanical and electrical theory of operation of the IBM Single Disk Storage (Serial Numbers 00001 through 39999).

This manual was reviewed for accuracy on December 15, 1965. Users of this manual are cautioned that machine specifications are subject to change at any time and without prior notice by IBM. System diagrams (logics) at the engineering change level for a specific machine are included in each machine shipment.

The Maintenance Diagram section of the System Diagrams Manual for the Single Disk Storage is referenced throughout this manual and may be used to supplement the instructions described in this manual.

This manual is divided into five chapters:

Chapter 1 contains an introduction to the machine with details of its capabilities, capacities, and applications.

Chapter 2 describes functional components of the machine.

Chapter 3 describes the theory of operation of machine functions.

Chapter 4 provides information on power requirements and describes power distribution and sequencing within the machine.

Chapter 5 describes special features of the machine.

The companion publication, IBM Field Engineering Maintenance Manual, Single Disk Storage (Serial Numbers 00001 through 39999) (Form 227-3668-0) provides instructions to diagnose malfunctions and accomplish repairs on this machine.

Scope of this manual is limited to the disk drive only. Power supply, operator controls, and attachment circuits are described in the IBM Field Engineering Theory of Operation (Manual of Instruction), 1800 Data Acquisition and Control System Data-Processing Input/Output Features (Form 227-3617-2).

This manual (Form Y26-3669-0) is a reprint of Form 227-3669-0. Only the prefix of the form number has been changed to indicate the Restricted Distribution status of the manual. Form 227-3669-0 was a complete revision of and superseded Form 227-5985-1 which described the IBM 2310 Disk Storage.

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- Designated as IBM Single Disk Storage
- Two machines, which are functionally similar, contain mechanical differences and can be identified by the machine serial number.
- Contains a removable single disk cartridge.
- Reads from, and writes data on cartridges which can be interchanged with other machines.
- Contains two magnetic read/write heads which are moved by a voice-coil actuator positioning system.
- Machine has a data rate of 720,000 bits per second (or almost 35,000 twenty-bit words per second).
- Signals from the using system cause the machine to perform its basic functions of access, read, and write.

1.1 MACHINE DESCRIPTION

The IBM Single Disk Storage (Figure 1-1) is a high performance, magnetic disk storage of exceptional reliability which provides random or sequential access storage capability to a using system for reading and writing of data.

One or more machines may be installed within a single enclosure of an I/O device, or the machine may be located in the cabinet of a central processing unit. It can write and read back more than ten million bits of information on a single magnetic disk.

The machine uses the IBM 2315 Disk Cartridge which consists of a single 14-inch diameter magnetic disk that is permanently housed within a 15-inch diameter plastic cartridge.

Machine operation is controlled by command signals initiated by the using system. The machine contains SLT components and provides an electrical interface of SLT logic signals. The functions of data reading and writing, head selection, sector indicatic actuator drive control, and safety interlocking are accomplished through internal circuits of the machine.

1.1.1 Machine Identification

- Machines are identified by serial numbers.

Two different machines are used for system applications. Although both machines are functionally similar, each contain differences in the design of some component parts.

Serial numbers have been assigned to each machine and may be used for identification purposes to denote the type of difference associated with a particular machine. Serial numbers are located on the edge of the base plate, below the drive magnet. Assignment of serial numbers for respective machines is shown in Table 1-1.

1.2 SYSTEM APPLICATIONS

- One or more machines may be used for I/O unit application in a system installation.
- Machine may be installed in CPU to increase system storage capacity.

The IBM 1800 Data Acquisition and Control System uses the IBM 2310 Disk Storage, Models A1, A2, and A3 for I/O unit application. Model A1 contains

Table 1-1. Serial Number Assignments

Type of Machine Difference	Description	Machine Serial No.
Mechanical Differences	208v, 60 Cycle 115v, 60 Cycle 208v, 50 Cycle	00001 and u
Power Requirement Differences	115v, 60 Cycle 208v, 60 Cycle 208v, 50 Cycle	10101 and u 20101 and u 30101 throu 39999

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NOTE: The illustrations in this manual have a code number in the lower corner. This is a publishing control number and is not related to the subject matter.

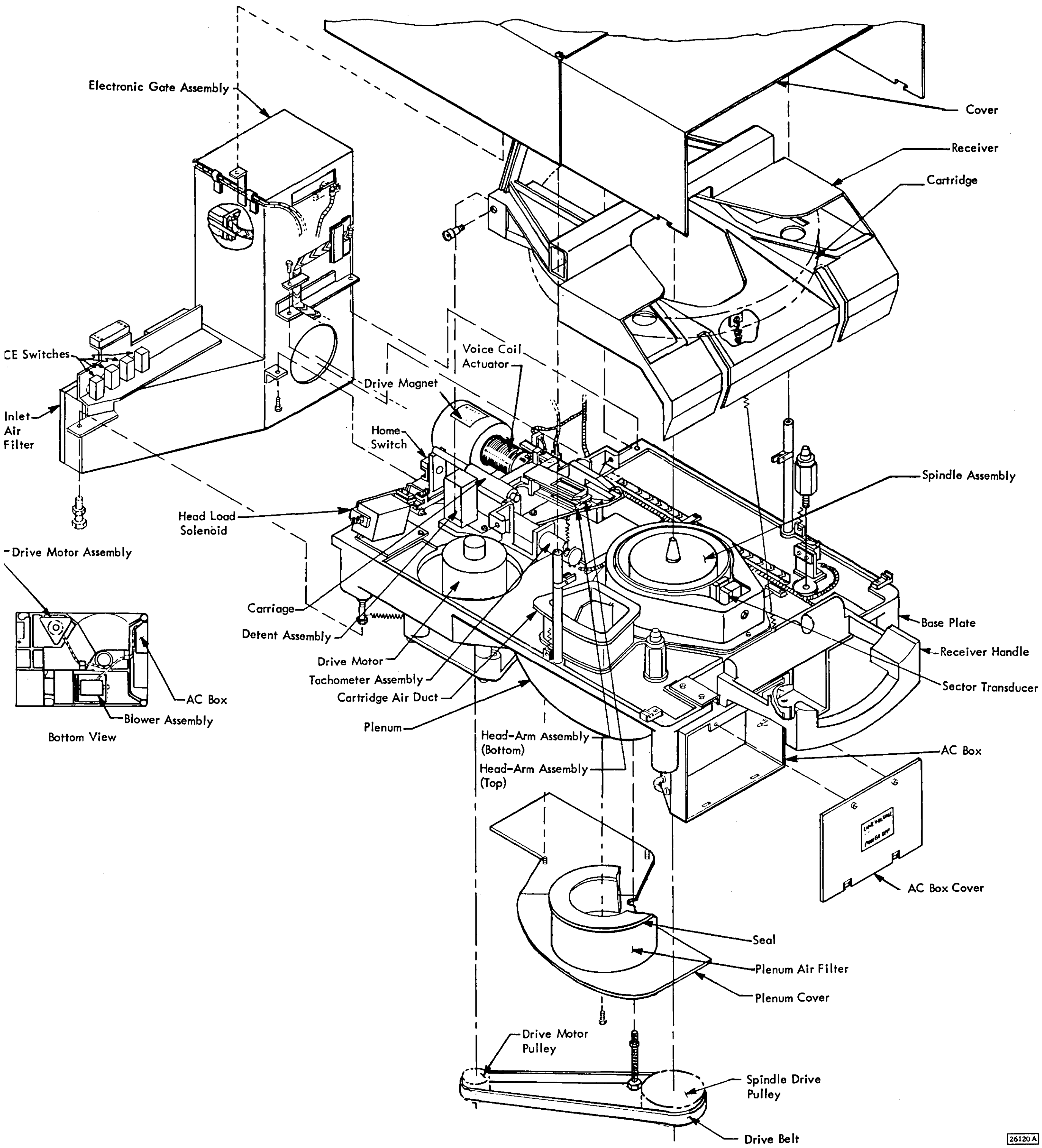


Figure 1-1. IBM Single Disk Storage

one single disk storage; Model A2 contains two; and Model A3 contains three.

The IBM 1130 Computing System uses one single disk storage which is located in the IBM 1131 Central Processing Unit, Model 2A or 2B to augment the System Storage capacity.

Information on the attachment circuits for connecting individual machines or combinations of machines to a using system is contained in the respective system manual.

1.3 DISK CARTRIDGE DESCRIPTION

- IBM 2315 Disk Cartridge is used with the single disk storage.
- A single disk, enclosed within a plastic cartridge, provides two data surfaces for reading and writing of data.
- Data written on one cartridge can be read, altered, or erased by any other machine used in a system employing the same data format.
- A special CE Disk Cartridge is available to the CE for maintenance purposes.

The disk cartridge is inserted into the machine by the operator. An access door in the cartridge is automatically opened, as the cartridge is inserted, to permit entry of the read/write head-arm assemblies which span the two data surfaces of the disk. When the cartridge is fully inserted into the machine, the disk adapter engages the drive spindle, and the disk becomes disengaged from the cartridge housing so that it can spin freely.

1.4 MACHINE OPERATING PRINCIPLES

- The access mechanism moves the read/write heads directly from one data cylinder to another without returning to a home position.
- Access motion in a forward or reverse direction is accomplished by incremental detent-step action.
- Two magnetic head-arm assemblies provide for reading and writing of data on each disk surface at any of 203 cylinder positions.
- Head selection, and reading and writing of data is under control of the using system.

Description

Machine operation is under control of the using system. Accessing is initiated by drive pulses supplie by the system control. A voice-coil actuator moves the carriage (with read/write heads attached) to any one of 203 two-track cylinder positions. At each cylinder position, data can be processed on the upper or lower disk surface by selecting the upper or lower read/write head.

Incremental track-to-track motion is employed for all accessing. The voice-coil actuator moves the carriage assembly either one or two tracks for each actuator drive pulse received from the system An additional signal from the system establishes whether the actuator must move the carriage forward or backward to arrive at the correct track address.

A CE panel with control switches is located on the back of the machine to permit manual operation of the access mechanism for maintenance purposes. These switches can be used only when the CE interlock (CPU) signal cable is disconnectec from the electronic gate.

1.5 TRACK FORMAT

- Control of track format is accomplished by circuits in the using system.
- Details of format organization for a given system may be found in the Field Engineering Manual of Instruction for the particular systen involved.

1.5.1 Data Organization

Each disk is divided into 203 cylinders of two trac each (Figure 1-2). One track is on the upper disk surface and the other is on the lower disk surface. At each cylinder, either of the two tracks can be read (or written upon) by selecting the proper rea write head.

The sector is the basic addressable unit for reading and writing data within designated areas o the disk surfaces. Each two-track cylinder is divided into eight sectors for ease of block handlir The word capacity for each of the eight sectors depends on the format of the using system.

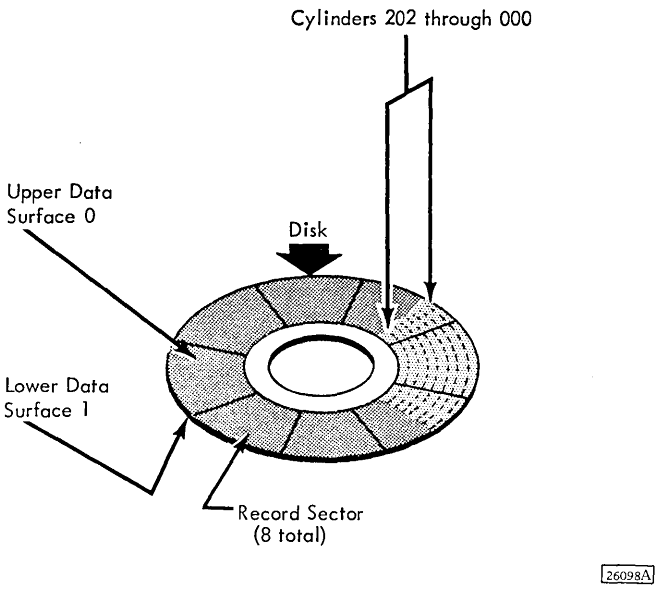


Figure 1-2. Disk Cylinder and Sector Arrangement

Each read/write command must address one of the eight sector surfaces available to the heads. Eight sector pulses, originating in the machine are supplied to the using system for indexing the reading or writing of data within a designated sector.

Some systems specify a sector capacity of 321 twenty-bit words. This would provide for using four (two-sector) areas of the disk for reading and writing of data. The specified sector capacity of 321 twenty-bit words would represent the maximum number of words to be transferred with a single system command. The total capacity of the IBM 2315 Disk Cartridge (using 200 tracks), employing the above sector capacity is 512,600 twenty-bit words.

1.6 CE PANEL AND CONTROLS

The CE panel located at the rear of the machine contains CE switches which permit the machine to be operated off line. The CW switches are normally inoperative and become active only when the CPU signal cable is disconnected from the machine. Upon disconnecting the cable, the machine is automatically placed in a read-select mode of operation to prevent inadvertent erasure of recorded information, and to allow the CE to examine the read circuit and recorded data. A detailed description of each CE switch is provided in Chapter 2.

1.7 OPERATOR CONTROLS AND INDICATORS

All operator controls and indicators are located on the respective cabinet or console in which the machine is installed. A description of controls and indicators is provided in the Field Engineering Manual for the associated equipment.

2.1 BASE PLATE

- The base plate serves as the basic structure to which all electrical and mechanical components are attached.
- Contains a plenum chamber and ducting ports for circulating air through the machine.

Description

All components of the single disk storage are mounted to a cast aluminum base plate. The base plate contains a plenum chamber on the bottom which permits filtered air to circulate upward. Mounting holes are provided for attaching shockmounts to install the machine within an enclosure. The CE switches and interconnecting terminal boards are located on the base plate along with other electronics. The base plate also contains circuit connections for the ac box, electronic gate, and dc power inputs for the detent assembly, drive magnet, head-loading electronics, and interlock circuitry.

2.2 COOLING AND PRESSURIZING SYSTEM

- Cools SLT cards in electronic gate, and cools the disk and base plate.
- Pressurizes cartridge to prevent the entry of contaminated air while cartridge is in machine.
- Contains two filters which are replaceable.

Description

Constant circulating air (Figure 2-1) provides for cooling SLT cards in the electronic gate and pressurizing the cartridge to prevent entry of contaminated air. Two replaceable filters, one located at the intake duct, next to the electronic gate, and the other located in the plenum chamber are serviced periodically to ensure that adequate airflow is maintained.

2.3 DISK CARTRIDGE AND RECEIVER

- Disk cartridge is inserted into machine by operator whenever data is to be read or written on disk

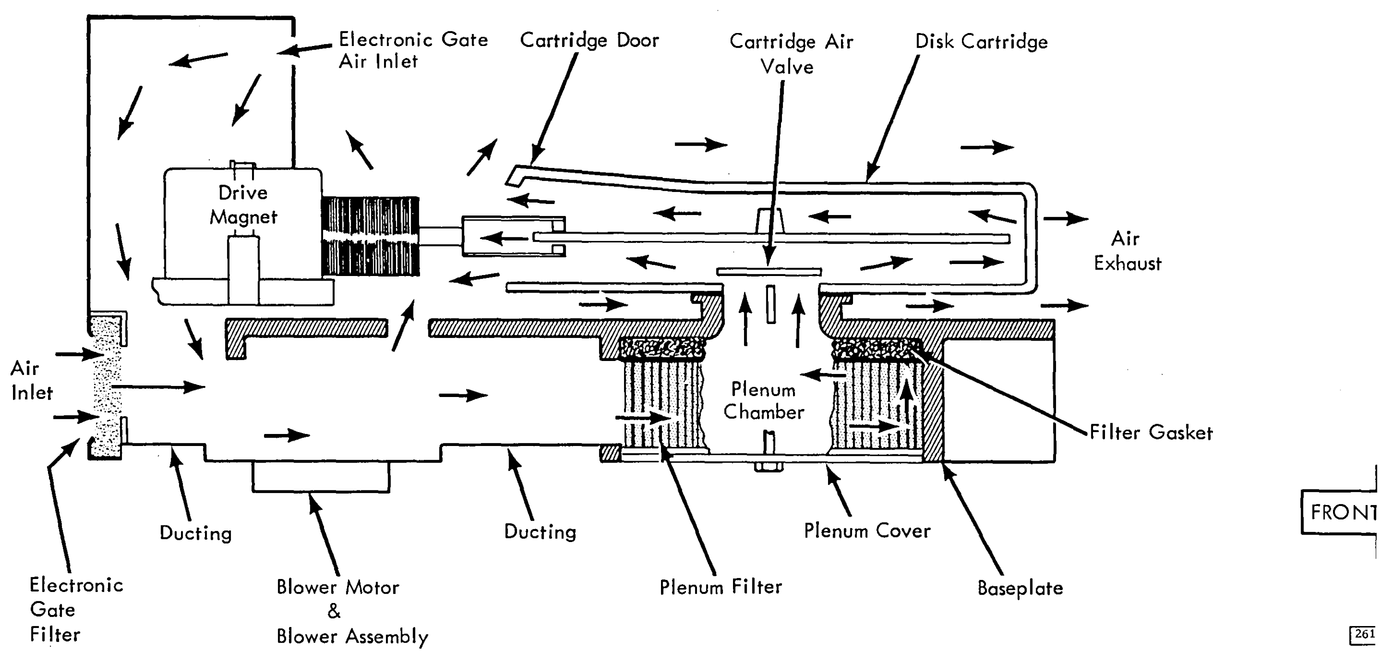


Figure 2-1. Cooling and Pressurizing System

- Disk cartridge is guided into machine and disk is positioned onto spindle by the cartridge receiver.
- Interlock circuits prevent cartridge from being removed from machine while disk is spinning and heads are loaded.
- +48 volts must be applied to machine before cartridge can be removed.

Description

The disk cartridge and receiver locate the disk on the spindle. Interlock circuits are designed into the receiver to protect the disk from improper handling while the cartridge is inserted or removed.

2.3.1 Disk Assembly

- Disk is permanently enclosed by cartridge.
- Disk recording band is approximately 2 inches wide.
- Each side of disk provides for 203 data tracks to be accessed.

The disk used in the Single Disk Storage (Figure 2-2) is 14 inches in diameter and is permanently enclosed by the cartridge which protects the disk from adverse environments and mechanical damage. A thin coating of magnetic material is applied to both sides of an aluminum substrate to provide the recording surfaces. The recording density is 100 tracks per inch, at a nominal linear density of 1,025 data bits per inch on the inside track.

Double frequency recording is used in which clock and data information are recorded in an interleaved manner so that the nominal density of magnetic flux reversals is 2,050 per inch on the inside track. A full track of information recorded as a single record has a capacity of 27,100 bits of data, or a total capacity for a disk of over ten million data bits. Considerations of data format will reduce this capacity somewhat in most applications.

The disk is clamped to a disk adapter assembly which is magnetically locked to the drive spindle when the cartridge is inserted into the receiver. A cone-shaped pin in the center of the drive spindle mates with a hole in the disk adapter to provide a precise disk location in the machine. The spindle and drive motor rotate the disk at 1500 rpm in a counterclockwise direction (when viewed from the top of the spindle).

A slotted ring mounted to the underside of the disk adapter is used with a transducer to generate sector pulses for data formatting. A double slot is used to indicate a reference point, while single slots are used to define all other sectors.

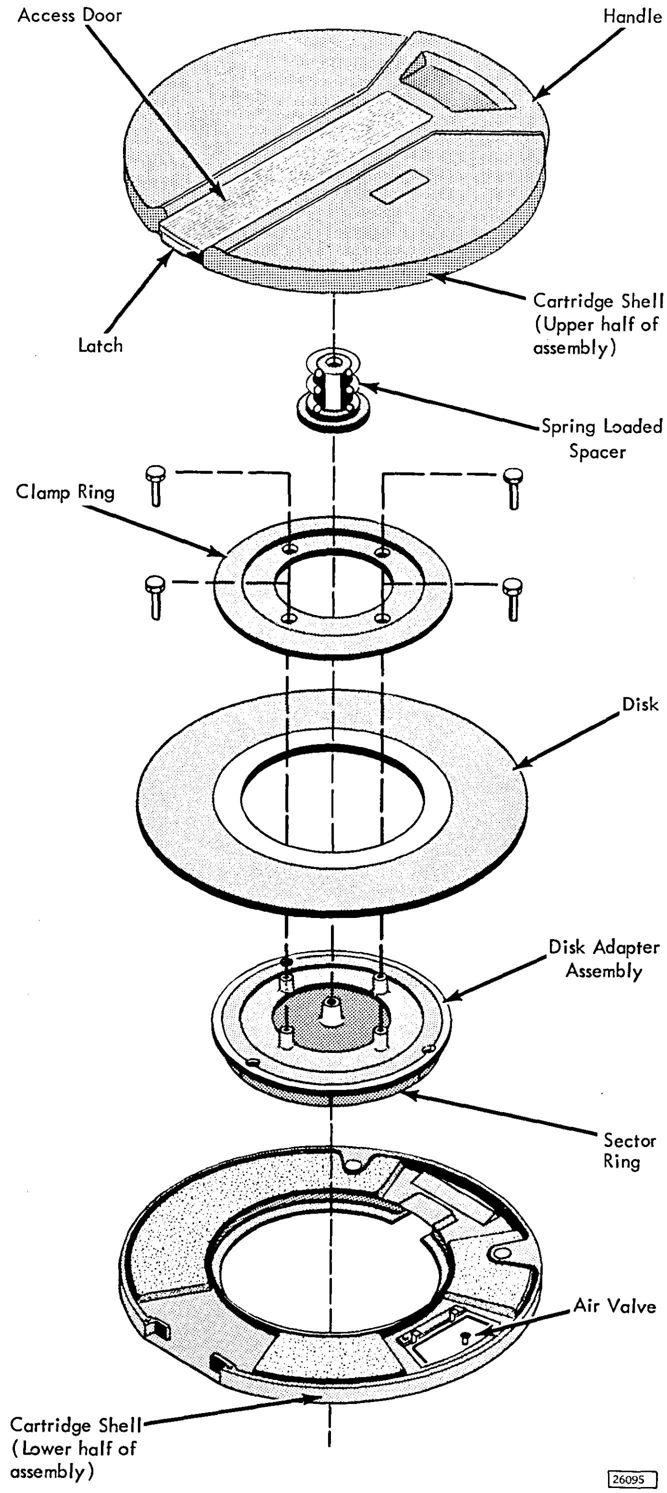


Figure 2-2. Disk Cartridge Assembly, Exploded View

2.3.2 Cartridge Assembly

- Protects disk from contaminents and physical damage.

- Aligns disk with spindle on machine.

The cartridge is circular with a diameter of 15 inches, a thickness of 1.445 inches, and a weight of approximately 4.5 pounds. A handle grip is molded into the cartridge housing to facilitate handling, and an area of the cartridge edge near the handle provides a space for labeling data contents.

The opaque, protective plastic cartridge (Figure 2-2) completely encloses the disk except for the bottom of the disk adapter. The disk adapter also serves to support the disk in the cartridge when it is out of the machine so that the recording surfaces are not touched. A hinged door located on the edge of the cartridge becomes unlatched and opens automatically to allow the magnetic heads to enter the cartridge as the cartridge is inserted into the machine. The disk is lifted off the supports in the cartridge as it is locked to the spindle, allowing it to rotate freely within the cartridge. A spring-loaded air valve, located on the bottom of the cartridge permits filtered air to enter from the machine and circulate within the cartridge. This air pressurizes the cartridge interior to prevent contaminates from entering while the disk is spinning. The circulating air exits from the cartridge through the opening which receives the read/write heads. When the cartridge is removed, the access door closes.

NOTE: The door must be manually latched by the machine operator to prevent contaminants from entering the cartridge when it is stored.

When the cartridge is out of the machine, a compression spring-loaded spacer depresses the disk downward to prevent contact between disk data surfaces and the cartridge housing. The spring action of this spacer also opens the door when the cartridge is initially inserted into the machine.

The disk cartridge may be stored either on edge or flat. The cartridge should never be "stacked" or subjected to "top loading". These storage conditions could result in deforming the diaphragm which supports the cone that centers the disk within the cartridge. The diaphragm could also be damaged if the cartridge is set down upon a protruding object. Damage to the diaphragm renders the cartridge unusable, and could cause damage to the read/write heads when cartridge is inserted into the machine.

2.3.4 Cartridge Receiver and Handle

- Cartridge receiver guides and positions disk onto spindle.

- Handle is interlocked with drive motor circuits to prevent inadvertent removal of cartridge while drive motor is operating.

- Cartridge in-place switch is contacted by cartridge to effect activation of interlock circuits.

Description

The cartridge receiver mechanism located on top of the machine serves as a guide for the cartridge when it is inserted or removed from the machine. The receiver and handle operate together. Functionally, the receiver forms a nearly horizontal slot, into which the cartridge is inserted and guided onto the spindle, and secured while the disk is rotated by the drive motor. The cartridge receiver, by action of lowering the receiver handle, is tilted at a slight angle to permit the cartridge to be inserted. The door in the cartridge is unlatched and opened by the cartridge door opener so that the read/write head-arm assemblies can enter the cartridge and span the disk surfaces. The handle is then raised causing the receiver to be lowered so that the disk cartridge becomes flush to seat on the spindle. Accurate alignment is achieved by positioning posts and the spindle cone. The cartridge housing contacts the cartridge in place switch whichever it is seated in the machine.

2.3.4.1 Operation of Receiver

The carriage must always be located at home position whenever a cartridge is to be installed or removed from the machine. Damage to read/write heads could result if this condition is not met.

2.3.4.2 Interlock Circuits

Interlock circuits protect the machine from improper operation. A file ready communication line is provided to the CPU to indicate proper file operation after safety and interlock circuits have been satisfied. The machine is removed from a file ready con dition whenever the cartridge interlock circuits or read/write safety circuits are activated.

During insertion of the cartridge into the machine, the drive motor is interlocked so that it cannot be started until the cartridge is fully in position and the disk is locked to the drive spindle. When the drive motor starts, the cartridge is locked into the machine to prevent its removal while the disk is spinning. The heads are loaded against the disk when all interlock conditions are satisfied, and after a time delay of approximately 1.5 minutes has elapsed. The time delay period allows clean air to flow through the cartridge and allows temperature stabilization of the disk before a file ready condition is indicated and file operations can occur.

To remove the cartridge, the drive motor is turned off, which immediately removes the file ready condition. The heads are unloaded automatically and the carriage moves to the home position. After a delay of about one minute, the disk stops and the cartridge becomes unlocked, allowing the cartridge to be removed from the machine.

2.4 SPINDLE AND DRIVE MOTOR

- Spindle rotates the disk at 1500 rpm.
- Spindle contains a magnetic chuck which retains disk in a vertical and lateral alignment on spindle.
- Induction motor rotates spindle by means of a flat belt drive connected to spindle pulley.

Description

The spindle assembly (Figure 2-3) rotates the disk at 1500 rpm ±2.5%, by means of a pulley and flat-belt drive connected to a 1/12 hp induction motor.

2.4.1 Spindle Assembly

The complete spindle assembly is precision-ground at the factory to provide for accurately positioning the disk to eliminate vertical run out and lateral eccentricity. Eccentricity is controlled by the spindle cone which mates with the disk adapter. Vertical run out is controlled by the outer pole-piece of the magnetic chuck which also firmly anchors the disk against the spindle assembly. The pulley located at the base of the spindle is connected to the drive motor by a flat 0.018-inch (thick) belt. The spindle contains two ball bearings and is free-running without braking and locking provisions.

The magnetic chuck assembly is composed of inner and outer pole pieces containing a permanent magnet which exerts an effective magnetic force of ten pounds to retain the disk adapter onto the spindle. The edge of the outer pole piece is the only magnetic surface which contacts the disk adapter, thereby minimizing the amount of surface contact between adapter and spindle.

2.4.2 Drive Motor

The 1/12 hp induction motor has two poles and contains start windings which enable the motor to reach full rpm within a few seconds. Since the machine is designed for applications which involve 115 vac, and 208/230 vac, at 60 cycles, or 208/220 vac at 50 cycles, variations in motor speed for a given power application are compensated by the use of different sized pulleys and drive belts which enable the rated disk speed to be maintained.

2.5 HEAD POSITIONING SYSTEM

- Consists of the access mechanism which positions read/write heads to any one of 203 track locations on the disk.
- Read/write heads are mounted on a carriage which is moved by a drive magnet and voice-coil actuator.
- Carriage is detented in incremental steps of one or two tracks per step while accessing, and is also detented at the new track location.
- Access time for one or two tracks is 35 ms (15 ms for a single step motion and 20 ms delay before reading or writing of data). Average access time for traversing 200 tracks is 1520 ms.

Description

Positioning of read/write heads at various track locations is accomplished by the access mechanism. A lightweight carriage, two magnetic head and arm assemblies, a voice-coil type actuator, a head-loading mechanism, and two mechanical detents comprise the access mechanism. An access drive pulse from the using system causes the carriage to move in a forward or reverse direction, in a 10 or 20 milli-inch stepping mode, during an access stepping cycle.

Access logic circuits in the machine and a tachometer velocity transducer control the accessing operation. These circuits are conditioned by communication signals received from the system which establish the stepping mode, number of stepping cycles to be made, and the direction of carriage travel.

2.5.1 Carriage Assembly

- Moves inward toward and outward from spindle during accessing.

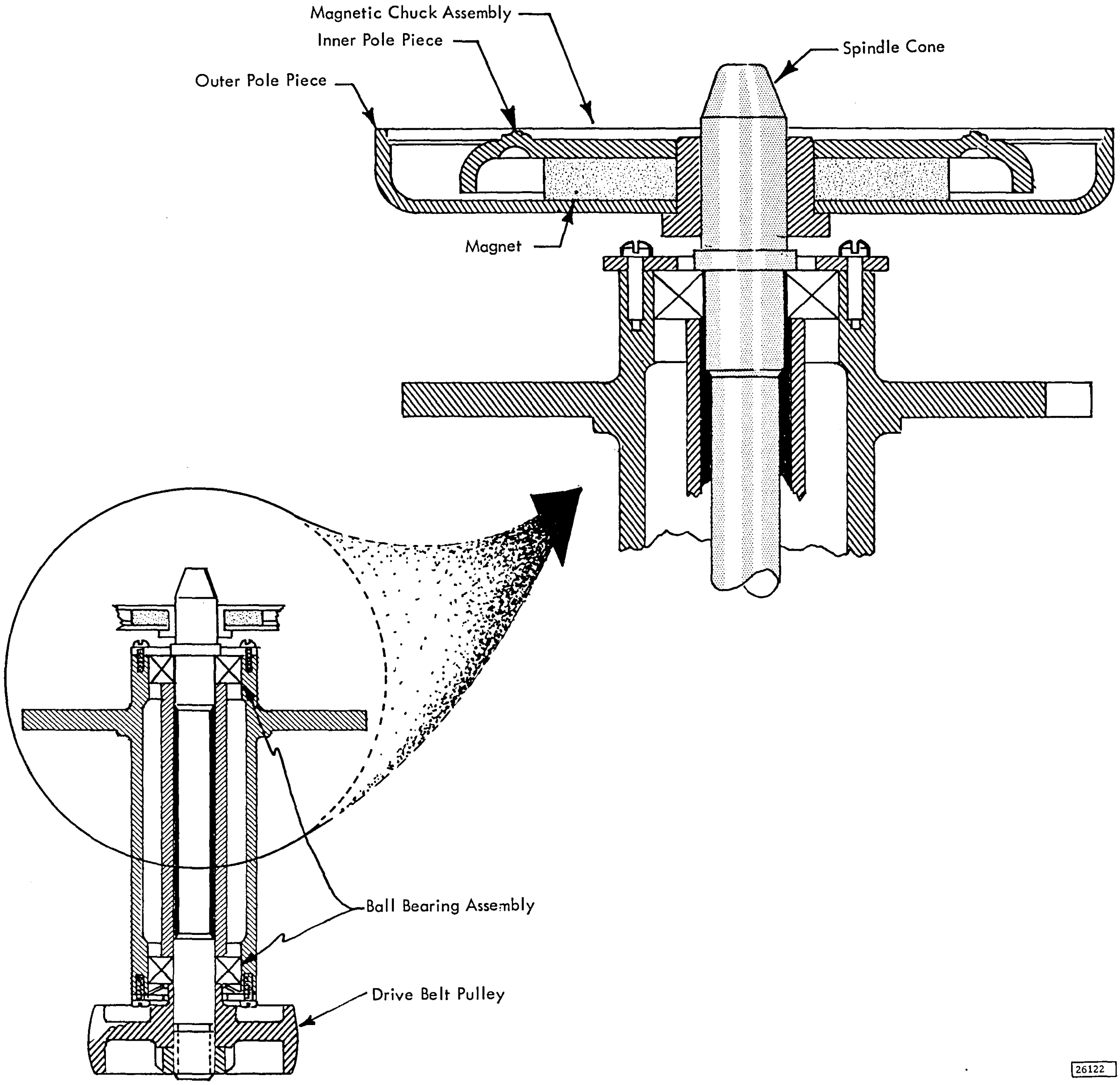


Figure 2-3. Details of Spindle Assembly

- Voice-coil actuator provides propelling force.
- Is mechanically linked with detent assembly and tachometer assembly which controls carriage motion.

The carriage assembly, containing the read/write heads, weighs approximately one pound and moves along a 3/8-inch diameter rail, moving a total distance of approximately 2 inches between the front and rear crash stops. The voice-coil actuator provides the force to drive the carriage. A detent rack, mounted on the left side of the carriage (when viewed from the front) is engaged by detents to locate the carriage at specific tracks. A tachometer assembly is attached to the carriage through an extension rod which moves with the carriage to enable the tachometer to effect dynamic braking of carriage motion within the required time of the step cycle.

A head-load cam assembly is attached to the carriage to maintain the heads-loaded condition of the read/write heads while the carriage is accessed.

2.5.1.1 Carriage Operation

The carriage is supported by a steel rail and a sliding guide which accurately guide the carriage motion. The voice-coil is attached to the rear of the carriage and the read/write head and support arms are mounted to the front. A tachometer extension rod attached to the bottom of the carriage enables the tachometer to sense carriage velocity.

A precision detent rack is mounted to one side of the carriage. One of two chisel-pointed detents engages this rack to provide final track positioning. Electro-magnets drive the proper detent into engagement with the rack when energized.

The magnetic heads are loaded against the disk by a rocker arm spring assembly actuated by a cam attached to the carriage.

The arms supporting the magnetic heads are mounted at a slight angle to the carriage centerline. This angle allows the head-recording elements (which themselves are at a slight angle relative to their mounting arms) to move on a radius of the disk with the read-write and erase gaps perpendicular to the recorded tracks. The heads are loaded against the disk with sufficient force to provide an air-bearing film of approximately 150 microinches.

2.5.2 Head Load Mechanism

- Disk must be up to normal running speed to create an air bearing to fly the heads at a proper distance from disk surfaces before heads are loaded.
- After the disk is up to full speed, heads are moved closer to the disk surfaces by the head loading mechanism until the heads are positioned 150 microinches from the disk surfaces.
- Heads unload when disk speed is less than 70% of full rpm, or when power is removed from the drive motor.
- With power to the machine turned off, head-arm assemblies are unloaded, and in a retracted position with heads poised above disk surfaces.

Description

The head load mechanism (Figure 2-4) causes the read/write heads to move near the disk surface so that reading and writing of data can take place. Head loading is accomplished while the disk is rotating at full speed. A pivot plate is caused to rotate (tilt) against roll pins which extend a cam between the cam followers of the spring-arm assembly which effect loading of heads. The pivot plate is rotated by an actuator link attached to the plunger of the head load solenoid. When the solenoid is energized, the plunger is retracted thereby resulting in the loading of heads.

The pivot plate remains tilted (due to action of the solenoid) while heads are loaded. The head load mechanism is interlocked with logic circuits of the machine so that head loading occurs only when the disk has reached full speed, and 90 seconds have lapsed from the time the drive motor became energized.

Heads unload when the solenoid becomes de-energized. In the absence of solenoid force, a tension spring attached to the pivot plate rotates the pivot plate outward, thereby retracting the cam from the cam followers of the spring-arm assemblies and unloading the heads. Logic designed into the machine interlock circuits also causes heads to unload if power is accidentally dropped, or if the disk speed is reduced to less than 70% of 1500 rpm.

2.5.2.1 Head Loading Operations

The cartridge is inserted into the machine when the carriage is at home position, spindle drive power is off, heads are unloaded, and interlock circuits are activated to prevent accidental start of drive motor when cartridge is not fully inserted into machine.

After cartridge is fully inserted into machine, and receiver handle is raised to lock cartridge to drive spindle, interlock circuits prevent loading of heads before a 90-second period has elapsed.

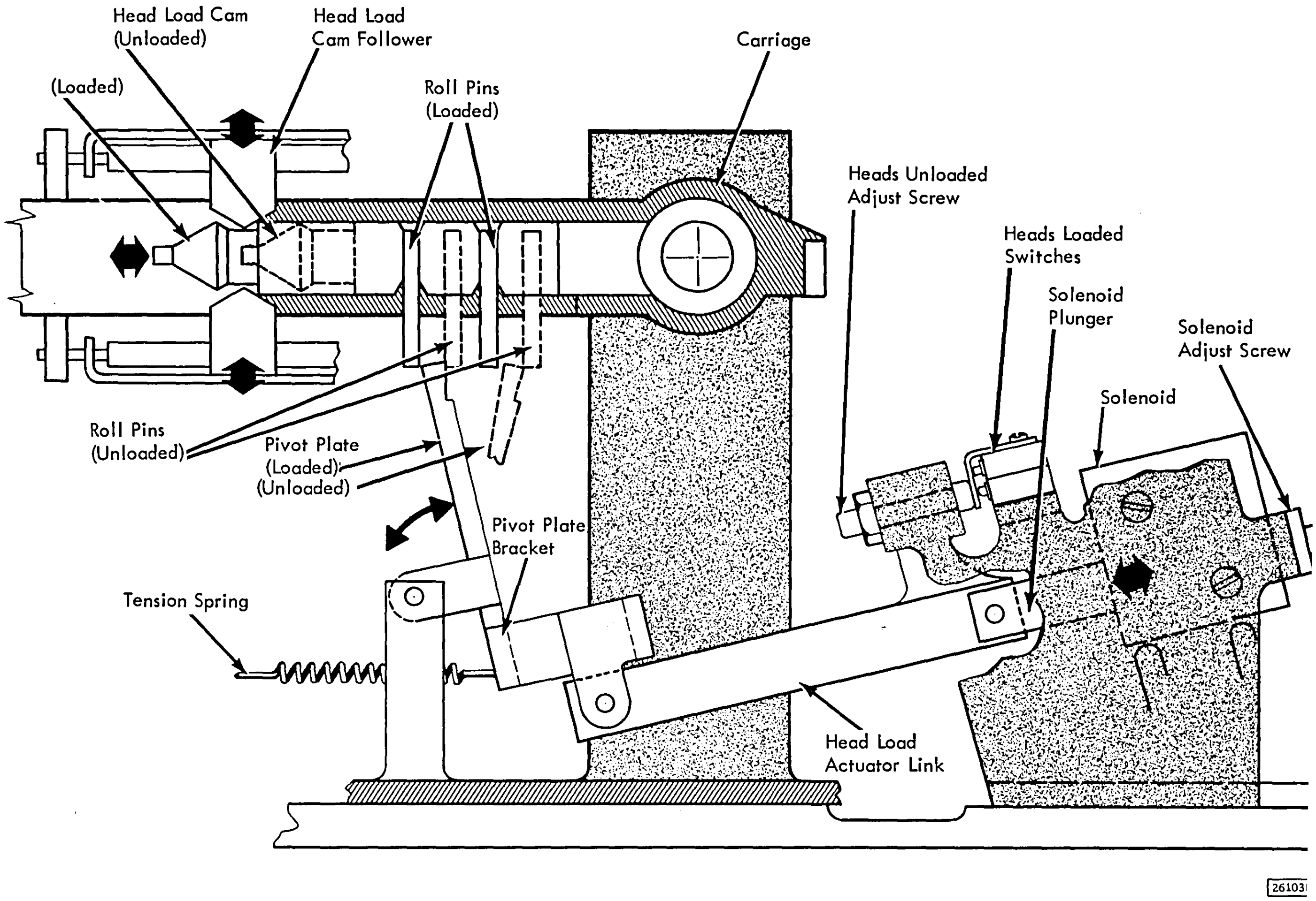


Figure 2-4. Head Load Mechanism (View from Rear of Machine)

The application of power to the drive motor causes the 90-second-delay timer to operate. The 90-second-delay period enables the disk temperature to become stabilized.

The head load solenoid is energized after the 90-second-delay timer stops. The head loading operation occurs automatically during the power on sequence. See Maintenance Diagram Manual, Power On Sequence Chart 601. The linkage attached to the solenoid plunger causes the head-load switch to transfer. This switch turns off the solenoid pick current (which is relatively high), so that the solenoid hold current (which is relatively low) retains the solenoid plunger in the attracted position to maintain the head loaded condition.

The position of the head-load switches, which provide the file ready signal and remove high pick current from the solenoid, must be physically located so that both switches transfer when the plunger is attracted. Alignment of these switches is accomplished during adjustment of the head-load mechanism.

2.5.3 Detent Assembly and Rack

- Positions the carriage at a precise track location during accessing.
- Detenting is accomplished by an electro-magnet which causes the detent to engage the rack when magnet is energized.
- Detent engages the rack at 10 or 20 milli-inch spaces during the accessing cycle.
- An access operation requiring the carriage to move three or more tracks from an odd to even track location is accomplished by an initial 10-mil step, followed if necessary by a series o[f] 20-mil steps.

Description

The detent assembly mounted on the baseplate contains two electro-magnets and two detent pawls, one for odd numbered tracks and one for even numbered tracks, which are used to position the carriage at a precise track location during an access cycle. A detent rack mounted on the movable carriage is engaged by the detent pawls to effect carriage positioning (Figure 2-5). Only one detent pawl engages the rack at a given track location. When the carriage is being accessed, the detent pawls engage and disengage from the rack, while the carriage is moved incrementally in a ten or twenty-mil, step-by-step manner. The carriage must be accessed within 3 mils of the required track position in order for the detent to engage the proper tooth on the rack.

2.5.3.1 Arrangement of Detents

The odd detent, located farthest toward the rear of the machine engages the rack to locate odd tracks on the disk (for example: tracks 041, 043, 045, etc.). The even detent, located toward the front of the machine engages the rack to locate even tracks (for example: tracks 040, 042, 044, etc.). The detent rack (Figure 2-5) contains 122 usable teeth (out of a total of 125) and is machined so that teeth are equally spaced 0.020-inch apart. Only one detent, odd or even will engage with the rack at a given track location.

The two detents are spaced 0.410 inch apart (with an odd multiple of 10) so that one of the detents is opposite a crest on the rack when the other detent is engaged with a tooth in the rack. The detent pawls are beveled at the tip to mate with the pitch-angle of teeth on the rack.

The first tooth of the rack is not used. Tooth locations 0 through 40 (View A, Figure 2-5) can be engaged by the even detent only, to locate the carriage at even numbered tracks.

The odd detent engages the rack, beginning with tooth location 42, to locate the carriage at odd track number 1 (View B, Figure 2-5).

The even detent is used as an indicator for visually determining the carriage position at all track locations (Figure 2-6). Calibrated marks on the carriage are spaced 20 tracks apart with numerals at 40-track intervals. Calibrated marks on the detent rack are located at alternate teeth (4-track intervals). Carriage position can be determined by counting the numbers and marks at the carriage location adjacent to the even detent, then adding or subtracting marks on the detent rack for the exact track location. (Keep in mind that the even detent engages the rack at even track locations and the odd detent engages the rack at odd track locations.)

2.5.3.2 Detent Operation

Since the detent is spring loaded away from the rack, the detent magnet must be energized in order to seat the pawl into the rack. Conversely, the detent magnet must be de-energized for the spring loaded pawl to be retracted from the rack.

The system control circuits establish the total number of drive pulses which will be sent to move the carriage across several tracks to arrive at a predetermined track location. The machine access logic circuits responds to each individual drive pulse to accomplish pull in and drop out of detents during access operations.

The machine accesses in a 20-mil step mode when the carriage moves an even number of steps (from odd-track to odd-track, or from even-track to even-track). The engaged detent only, will operate between steps to position the carriage.

When the carriage is commanded to move an odd number of steps (from odd-track to even-track, or vice versa) the machine will initially change detents to take a 10-mil step, then it will use the same detent to move in 20-mil steps to arrive at the final track location.

The stepping-mode communication signal originating at the CPU establishes the required integrator trip level in the machine access logic for control of detents during each step cycle.

During an access cycle, the detent magnet is de-energized when the go latch is set by a drive pulse from the CPU. A 2.6 ms single-shot delay allows time for the detent to be retracted from the rack. After the 2.6 ms single shot delay has timed out, a drive current pulse is applied to the voice-coil actuator to move the carriage toward the new track position. After the carriage has arrived at the half-way point of the single-step cycle, as sensed by the tachometer, the integrator circuit causes the trip level detector to reset the go latch. Current is reversed in the drive coil, and the tachometer provides dynamic braking to bring the carriage to a halt while the detent magnet again becomes energized. The detent engages the rack to locate the carriage at the new track position. A total of 15 ms is required for the carriage to move a single step (10 or 20 milli-inches) after a drive pulse is received from the CPU.

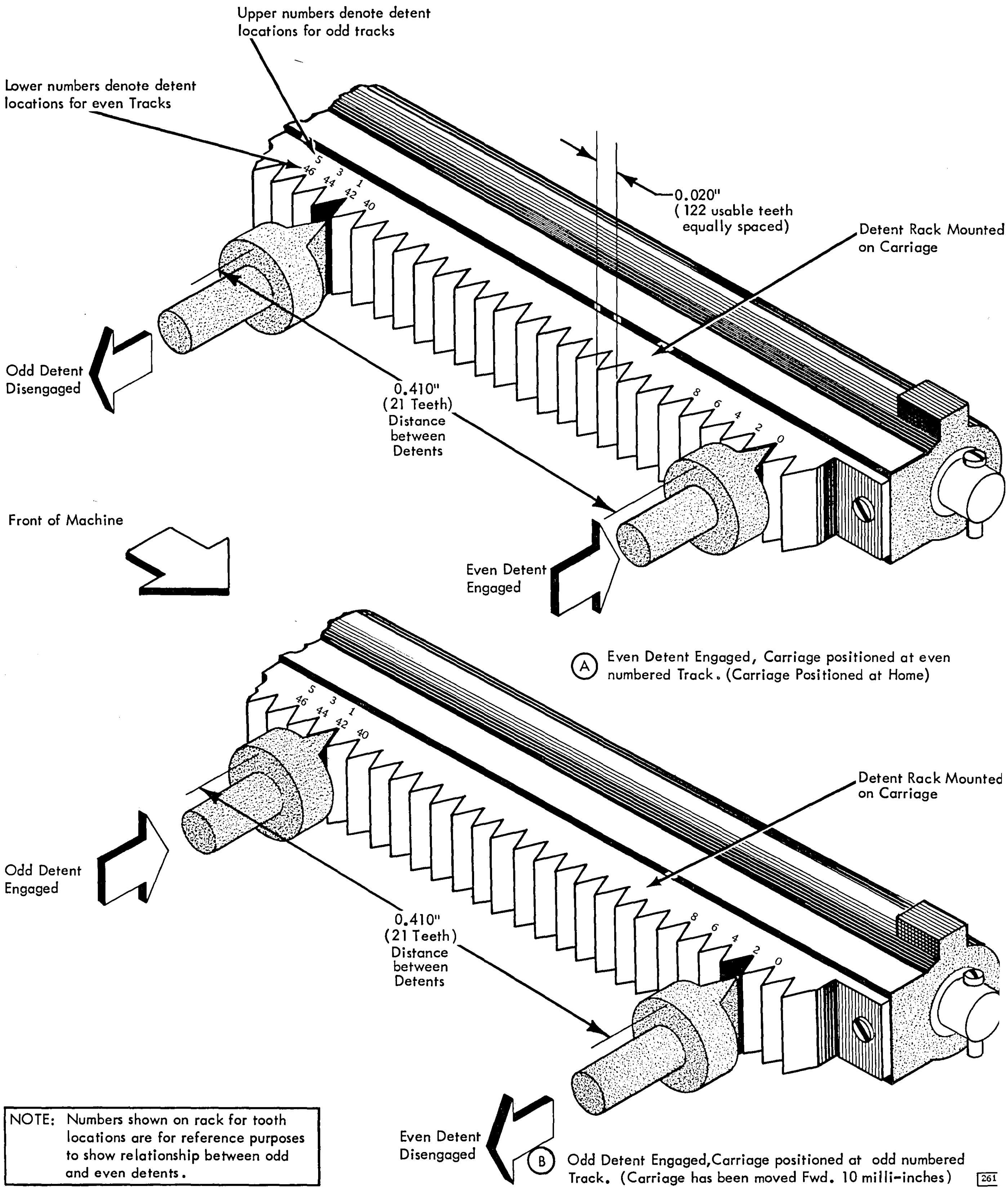


Figure 2-5. Detents and Rack, Relationship between Spacings

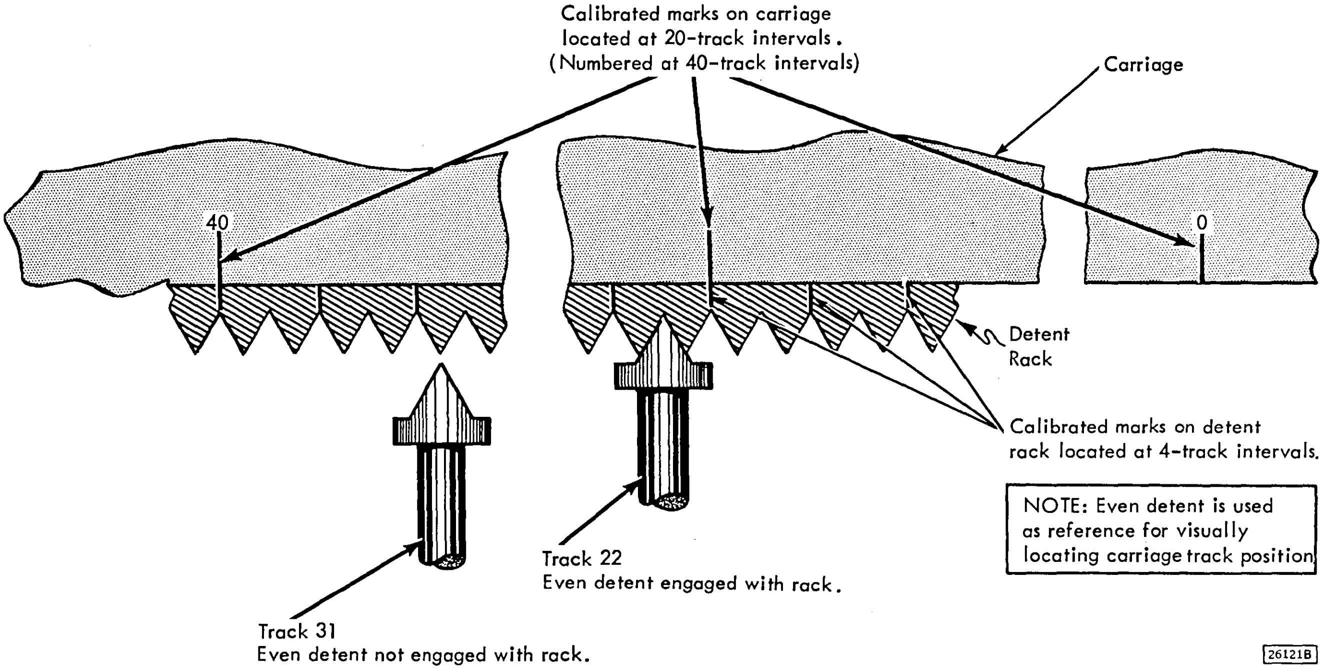


Figure 2-6. Calibrated Marks for Locating Carriage Position

The cycle of accessing and detenting continues until the carriage arrives at the final track location containing the address selected by the CPU.

2.5.4 Drive Magnet and Voice Coil

- Provides driving force to move carriage in a forward or reverse direction between crash stops.
- Current is applied to the voice-coil in one direction to effect acceleration of the carriage and is reversed to effect deceleration of the carriage.
- The rapid application and reversing of current in the voice-coil actuator causes the carriage to move in an incremental manner.

Description

The drive magnet (Figure 2-7) mounted at the rear of the base plate consists of a cylindrical permanent magnet which is smooth at one end and contains a smaller cylindrical pole piece extending through the

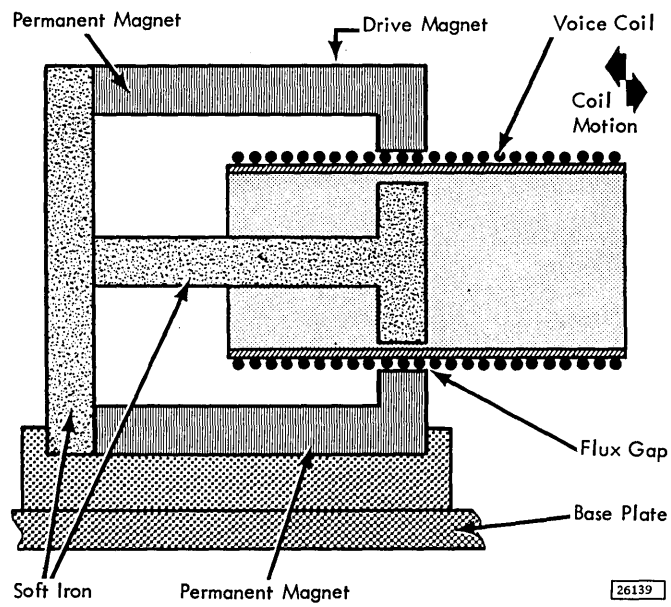


Figure 2-7. Drive Magnet and Voice Coil

center which creates a cylindrical flux gap at the other end of the magnet. The voice coil which is also a cylindrical shell, operates within the flux gap. The voice coil is secured to the carriage in such a manner that it can move freely in and out of the flux gap while it moves the carriage along the rail.

2.5.4.1 Drive Magnet and Voice Coil Operation

When a voltage is applied to the voice coil, a current flows through the coil windings which opposes the magnetic field in the flux gap. This creates an electromagnetic force on the coil causing it to be ejected from or retracted into the gap, depending upon the direction of current flow in the coil windings. This force causes acceleration and deceleration of the carriage.

When current is initially applied, then rapidly reversed in the voice coil, the carriage is caused to accelerate and then decelerate, during a single step cycle.

Access logic designed into the circuits provide for the carriage to be displaced either 10 or 20 milli-inches with each step-cycle time period. Approximately 2.6 ms delay is required to permit the detent to retract and 3.4 ms is required for detents to engage the rack to position the carriage at each track location, so that a total of 15 ms is required for each access cycle. The voice-coil actuator is active for approximately 9 ms of this total period.

2.5.5 Tachometer And Extension Rod

- Is a velocity transducer which produces an output voltage proportional to carriage velocity.
- Operates as a dynamic brake to effect stopping of the carriage during accessing operations.
- Is an integral part of the accessing logic for the machine.

Description

The tachometer assembly, located below and in front of the carriage is a velocity transducer which controls carriage motion during an access cycle.

The tachometer is essentially a stationary coil wrapped with several layers of aluminum and copper foil with each layer separated by an insulation material. A magnetized extension rod attached to the carriage is caused to move in or out of the coil while the carriage is in motion. The rate of displacement of the rod in the coil produces a voltage output at the coil leads at a level which is proportional to the carriage velocity. This voltage is fed back to the voice-coil control circuits to effect dynamic braking of the carriage. The tachometer circuit is shown in Figure 2-8.

2.5.5.1 Tachometer Operation

When the go latch is set by the drive pulse originating from the CPU, current is applied to the voice coil, the carriage is initially accelerated, and the tachometer produces an output voltage which charges a capacitor in the integrator circuit of the access logic. The amount of charge is determined by the integrator trip level detector which is preset for either a 10 mil or 20 mil step increment.

After the detector trip level is reached, which is approximately 1/2 the total distance of carriage travel, the go latch is reset. This action allows the tachometer voltage to apply reverse current to the voice coil. This change in current direction decelerates the carriage, and since the tachometer output is a function of carriage velocity, which is fed back to the voice coil, no output is obtained when the reverse current finally decelerates the carriage velocity to zero. Current then stops flowing in the voice coil, and the detent engages its rack for final positioning of the carriage at the new track location.

2.6 READ/WRITE HEADS AND SUPPORT ARM ASSEMBLIES

- Two magnetic head-arm assemblies are provided.
- Magnetic heads read, write, and erase data on or from magnetic surfaces of the disk.
- The two elements of the magnetic head, read/write coil and erase coil, are built into a gliding shoe.

2.6.1 Head-Arm Assembly

The head-arm assembly (Figure 2-9) consists of a magnetic head with integral read/write and erase coils and a connecting cable and plug. One head-arm assembly spans the upper disk surface and another spans the lower disk surface. The magnetic head, mounted in the gliding shoe, consists of an erase pole gap following a read/write pole gap by 0.045 inches.

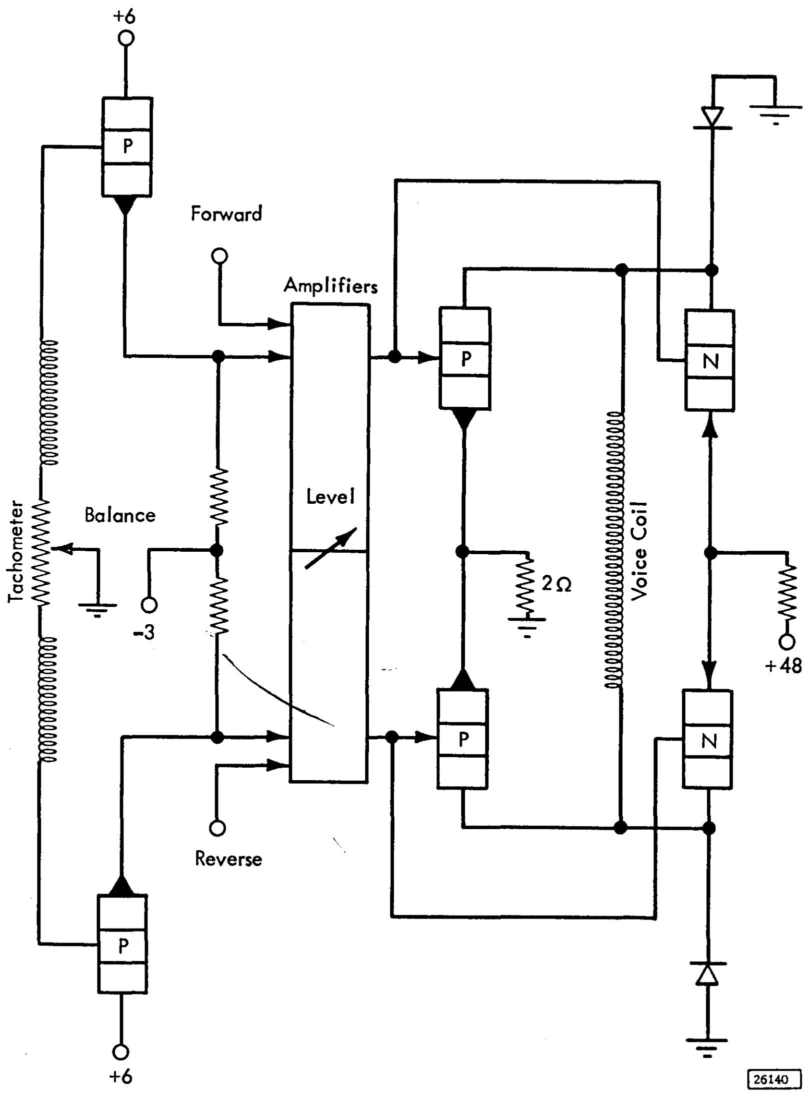


Figure 2-8. Tachometer Circuit

The erase coil is electrically connected to the center tap of the read/write coil and is energized whenever writing takes place. The erase pole tip is designed in the form of a yoke with a 0.005 inch gap. This trims the width of the written track from 0.008-inch to 0.005-inch to avoid fringing into adjacent tracks. Both coils are mounted on ring-type structures and are assembled in the gliding shoe.

2.6.2 Flying the Heads

The read/write head gliding shoe floats on a film of air (Figure 2-10) which is generated by the rotating disk. The air between the gliding shoe and the disk acts as a lubricant. Air as a lubricant has two main advantages. It has a small frictional value and maintains a constant film thickness at varying temperatures.

The air film lubricant also separates the shoe and disk surfaces so that no wear or abrasion can occur. As the disk turns, the air forms a wedge between the disk and the shoe. With a given load, the shoe "flies" or balances at a height proportional to the air velocity. Thus, the gliding shoe flies at a height of from 125 microinches at the inner track to 160 microinches at the outmost track (150 microinches, nominal).

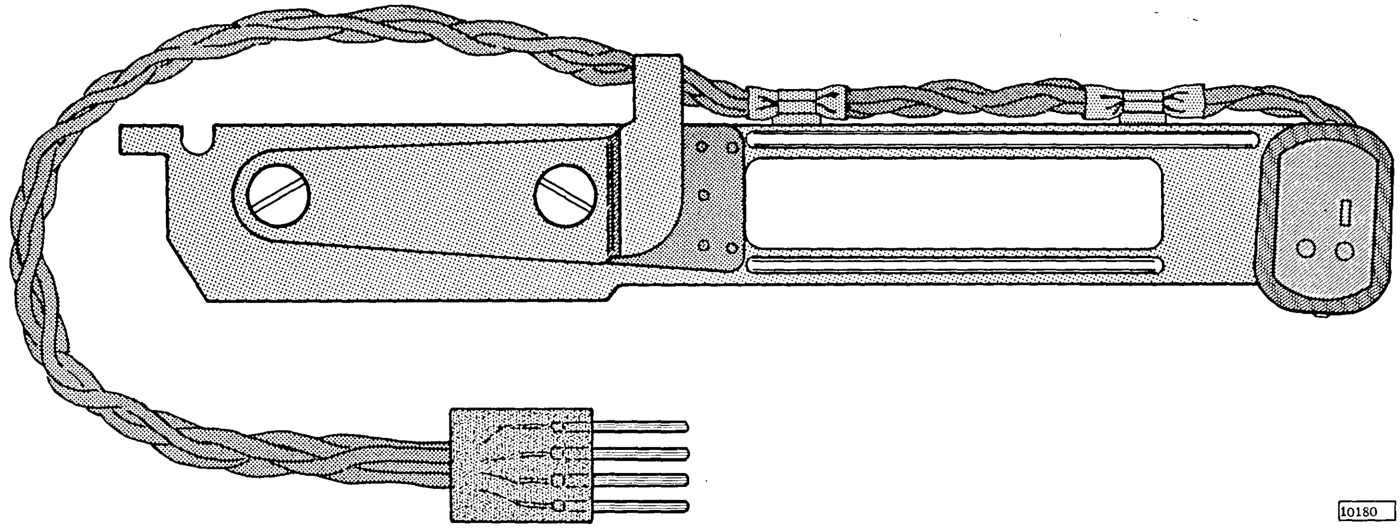


Figure 2-9. Head Arm Assembly

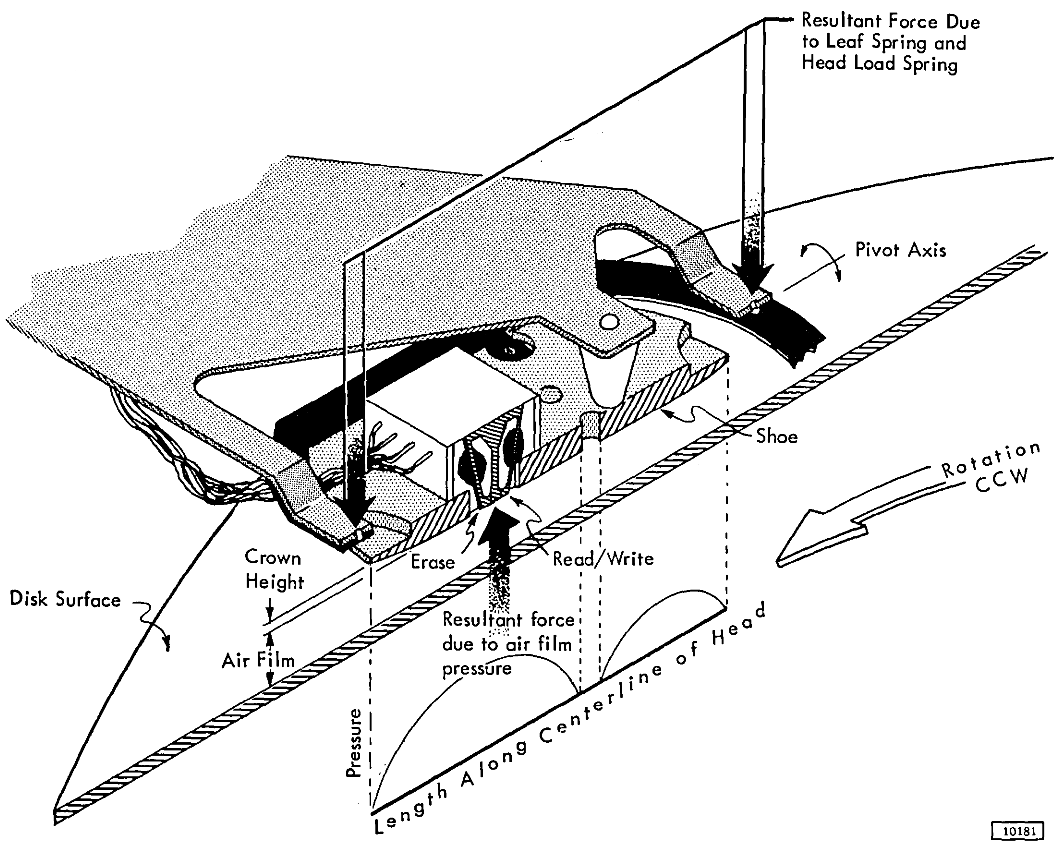
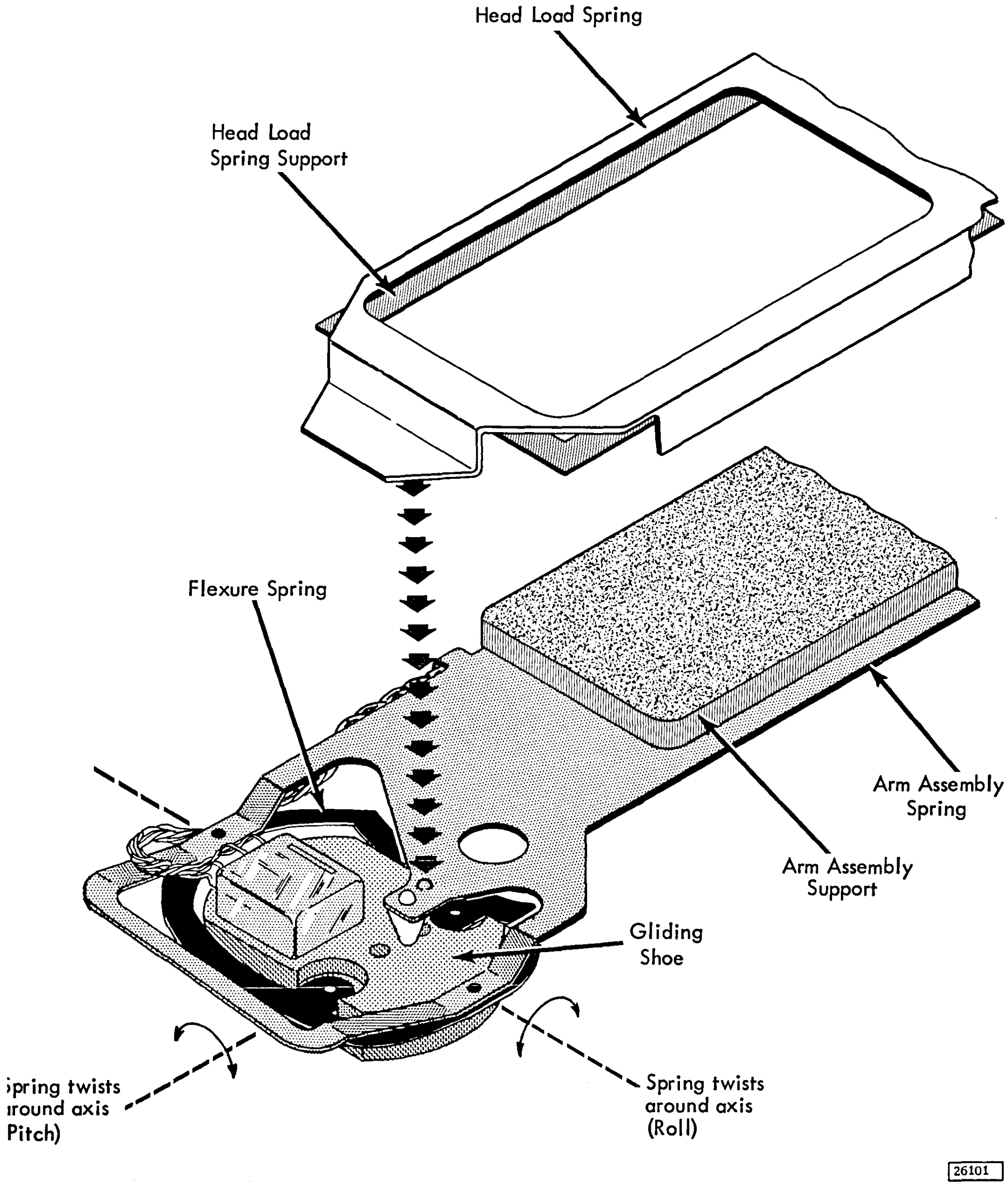


Figure 2-10. Flying the Read/Write Head

2.6.3 Maintaining Disk-Gliding Shoe Equilibrium

The read/write head must be supported so that it is held in the correct position over its track. A head-load spring holds the gliding shoe down against the pressure of the air cushion so that the correct shoe-to-disk spacing is maintained (Figure 2-11). The leaf spring on the arm assembly gives the head freedom to move up and down for vertical translation around an axis tangentially and radially to the track. The head is mounted on a flexure spring which allows the head to flex up and down for pitch and roll deflections relative to irregularities in the disk surface. Together, these features allow freedom of the head to follow disk runout and allow the head to assume the correct angle with respect to the disk. The head is restrained against motion for yaw, radial translation, and circumferential translation.



'igure 2-11. Head Assembly and Head Load Spring

2.7 SECTOR DETECTOR

- Is a transducer which divides segments of the disk by electrical pulses.
- Eight sector pulses and one reference pulse are generated for each revolution of the disk.
- Pulses are used by CPU for format purposes and are used in machine logic circuits for speed detection.

Description

The sector detector (Figure 2-12) consists of a transducer assembly located in front of the spindle and an SLT card. The transducer produces a pulse whenever a slot in the sector ring (on the disk adapter) rotates through the transducer. These pulses are received by the CPU, and enable the system to establish indexing of data on the disk for format purposes. The sector pulses are also used by machine logic circuits to check speed of the disk.

The entire transducer assembly is potted so that no adjustments can be performed on the assembly other than positioning of the assembly radially around the flange of the spindle housing to relocate index timing. An adjustment of gain in the transducer amplifier is accomplished on the transducer SLT card.

The sector ring (located on the disk adapter) is a non-ferrous aluminum-alloy metal which contains a total of nine sector slots. Eight of these slots are equally spaced around the ring to generate sector pulses at 5 ms time intervals. An additional slot which is located adjacent to one of the sector slots, generates the reference pulse for each revolution of the disk at 40 ms time intervals. This signal is used for indexing purposes.

The transducer is essentially a three-legged transformer (Figure 2-12) with one leg functioning as the primary input and two legs functioning as the secondary output. The sector ring rotates between these primary and secondary windings to produce an output signal to detector circuits.

2.7.1 Sector Transducer Operation

- A single primary and two secondary coils are used in transducer to detect the presence of slots in the sector ring of disk adapter.

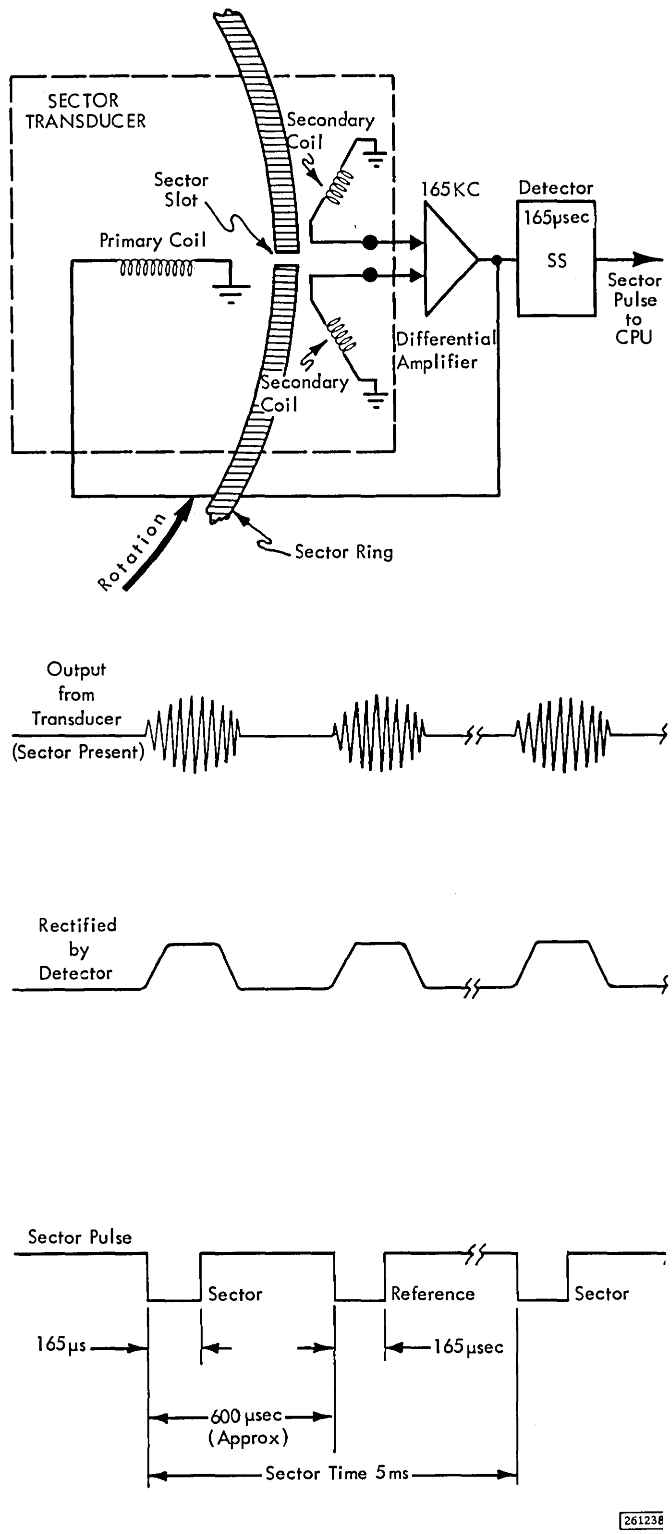


Figure 2-12. Sector Transducer and Signal Patterns

- With air gap between primary and secondary, the secondary output is at maximum coupling.

- Secondary output signal is amplified, shaped, and converted to pulses by SLT circuits.

The magnetic coupling from primary to secondary coils is very low when no sector slots are positioned between the poles. This low coupling is caused by eddy-current losses in the aluminum-alloy material of the sector ring on the disk adaptor. When one of the sector slots enters between the primary winding and one of the secondary windings, the magnetic coupling is increased for that secondary phase.

Since a feedback loop is connected from the output of the differential amplifier to the input of the primary winding, no oscillation is produced if the coupling is of the wrong phase. As the sector slot continues to pass through the transducer, the coupling to the other secondary winding begins to increase. Since both windings provide an input to a differential amplifier, no output is realized until a difference in signal amplitudes is present. As the sector ring continues to pass through the transducer, the slot advances until enough of the proper phase is supplied to produce oscillation.

At the first detection of oscillation the 165 μs single shot is fired, and a sector pulse results. At full disk speed (1500 rpm), sector pulses occur at 5 ms intervals. An extra pulse follows one of the eight sector pulses by 600 μs (approx.). This extra pulse, called the reference pulse is used to index the start of a revolution of the disk surface.

2.8 OTHER COMPONENTS OF MACHINE

2.8.1 Electronic Gate

- Houses all SLT Logic cards and provides for connection of signal cables from CPU.

- Is hinged to swing out to provide access for maintenance purposes.

Description

The electronic gate located at the right-rear of the machine houses the SLT logic cards (Figure 2-13) and contains connectors for control signal cables. Because of the requirements for specialized circuits, many discrete components are used and packaged on SLT cards. The electronic gate is hinged to swing out from the cover for maintenance purposes to provide access to the SLT cards.

Approximately 12 SLT cards are installed in the gate. Four cable connectors are provided. Power cards are located near the bottom of the gate where they are exposed to the maximum air-flow circulation in the gate. Connections for signal cables are located at the top of the gate.

Machine access adjustments and data separation adjustment are accomplished by potentiometers contained on appropriate SLT cards in the electronic gate.

An SLT card support serves to rigidly brace the outer edges of the cards with the gate housing to minimize card vibration. This support normally interferes with the bottom of the electronics gate to provide a preload on the ends of the SLT cards.

2.8.2 AC Box

- Houses the 90-second timer and motor start relays.

- Distributes ac power to disk drive motor and blower motor.

The ac box houses the 90-second timer and motor start relays which distribute ac power to the blower motor and disk-drive motor. The 90-second timer is self powered and is interlocked with the head loading mechanism by the machine on-off switch. Cabling which provides ac power to the blower motor and disk-drive motor is shielded to reduce noise in the system.

2.8.3 Protective Cover

- Completely covers top of machine to shield moving parts from possible obstructions and contamination by foreign particles.

- Channels the flow of circulated air to rear of the machine to effect cooling of components mounted on top of the base plate.

- Cover is secured to cartridge guide posts by two screws which facilitate its removal and installation for maintenance purposes.

Description

The protective cover is a two-piece telescoping housing which is secured to the top of the machine to completely enclose the cartridge receiver and exposed components. The cover provides a protective shield to prevent obstructions from contacting moving parts of the machine. The cover also prevents foreign particles, such as dust and dirt from settling on moving parts of the machine.

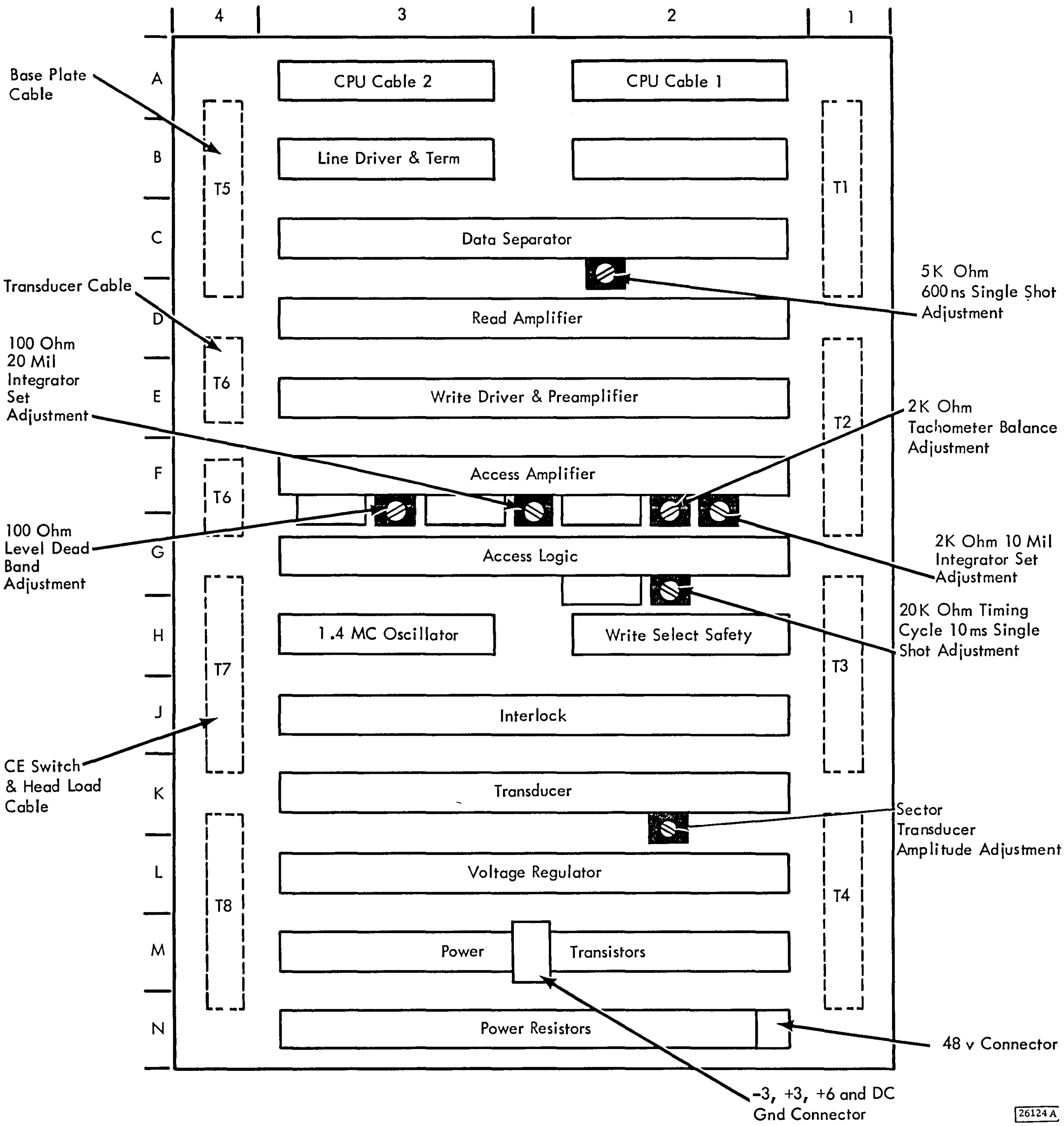


Figure 2-13. Arrangement of SLT Cards in Electronic Gate

The cover causes forced air emitted from the top of base plate to be channelled to the rear of the machine to effect cooling of electrical components mounted on the base plate.

The cover is secured to the machine by two exposed attachment screws which fasten the cover to the two cartridge guide posts. Removal and installation of the cover for maintenance of the machine is facilitated by ready access to these attachment screws.

2.9 CE SERVICE AIDS

- A CE control panel located at the rear of the machine is provided for the CE to operate the access mechanism independent of the system control circuits.
- The machine is placed in a read select mode of operation to prevent accidental erasure of recorded data whenever CE switches are used.
- The individual machine is placed off line whenever the CE switches are used.
- CE Disk Cartridge is used by the CE for maintenance purposes.

2.9.1 CE Control Panel

- Contains CE Switches.
- Permits manual operation of machine without input signals from CPU.

A CE control panel located on back of the equipment (Figure 2-14) is provided to permit limited operation

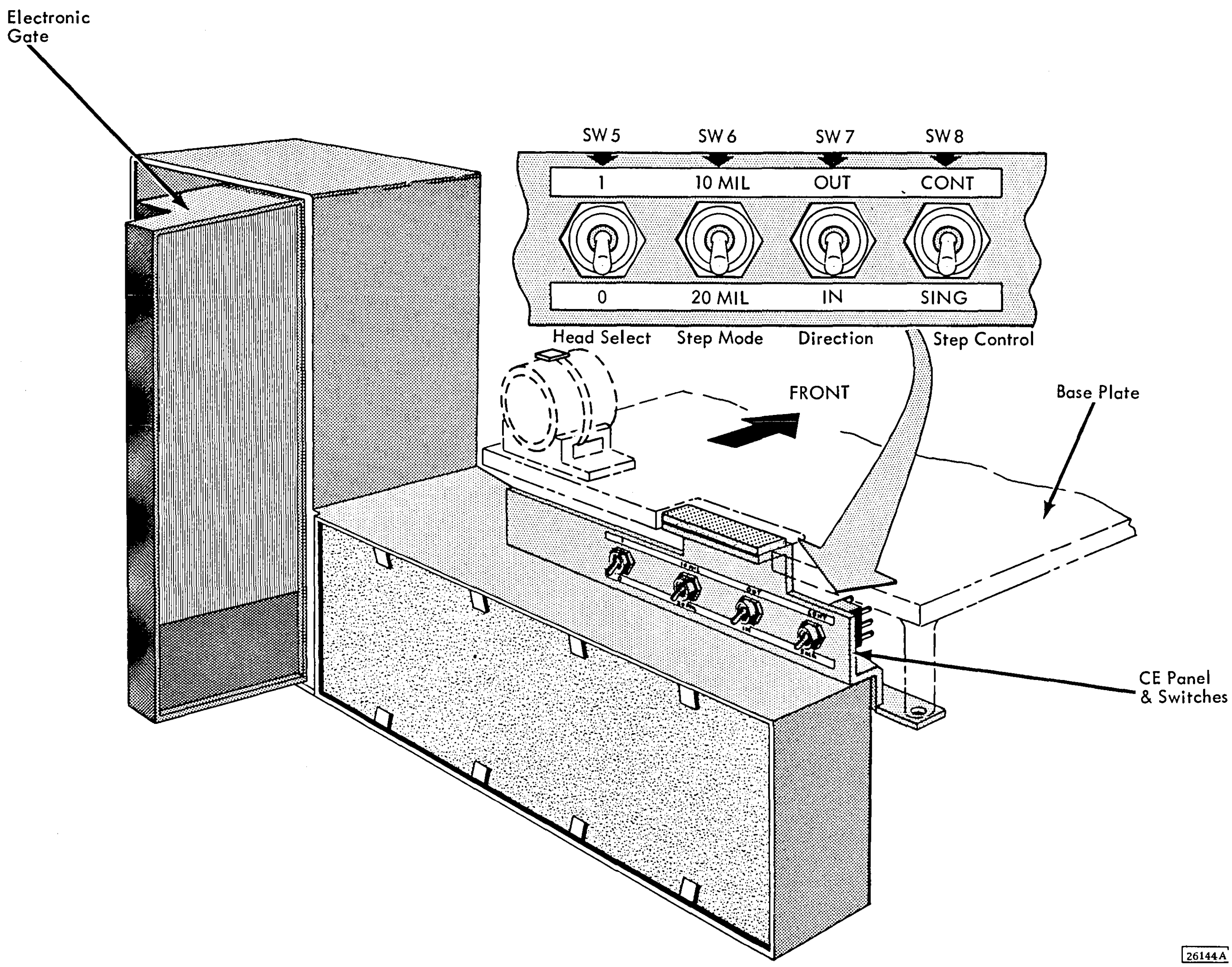


Figure 2-14. CE Panel and Switches

of the single disk storage independent of the using system, except for power input. The CE switches located on the panel are normally inoperative and become active only when the interlock CPU signal cable between the using system and the single disk storage is disconnected.

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

2.9.1.1 CE Switches

- Machine can be accessed to all track locations by use of the CE switches.

Four CE switches are provided on the CE panel; head select switch, step mode switch, direction switch, and step control switch. No CE control is provided on the machine for writing information.

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

Step Mode Switch. The step mode switch controls the actuator stepping mode by determining the distance to be traveled by the carriage for each step of the actuator. The switch has two positions (labeled 10 MIL and 20 MIL) which correspond with the distance to be traveled by the carriage (10 or 20 milli-inches) each time the step control switch is actuated.

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

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

When the switch is positioned for a continuous step movement, the actuator is caused to step continuously at a 15-ms rate in a forward or reverse direction as determined by the position of the direction switch. The actuator continuously steps in increments of 10 or 20 milli-inch steps as determined by the position of the step mode switch. The actuator continues this stepping cycle until the carriage strikes the mechanical limits of travel where the detent continues to operate without carriage motion, or until the step control switch is removed from the continuous step position.

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

2.9.2 Track Addressing

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

2.9.3 Disk Formatting Procedure

Because of high density recording on the disk cartridge, disk defects on new or used disks can effect data recording, causing loss of usable tracks. Using systems must provide for storage capacities based on 200 data tracks, allowing three spare tracks to ensure that stated capacities are maintained for the life of the cartridge. Whenever an IBM 2315 Disk Cartridge is used, a customer utility program must employ the following procedure to locate the defects: Flag the tracks in error, and identify the alternate track locations. The spare tracks in locations 200-202 should be used for alternate tracks.

2.9.4 Error Retry Procedure

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

2.9.5 Homing the Carriage

When initializing the carriage to the home position from an unknown location, the carriage must be decremented in single-track (10-mil) steps. By testing for home position after each step, the program can determine when track 000 has been reached. This can be accomplished by providing an access command to move the carriage 203 tracks, or more, in a reverse direction so that carriage accesses to home and stops. This will present an access home communication signal to the using system.

2.9.6 CE Disk Cartridge

The CE disk cartridge has three prerecorded tracks on each side of the disk. These tracks are used to make sector index timing adjustments (track 095), head alignment tracking adjustments (track 100), and detent positioning (track 105). The band of tracks, 90 through 100 are not to be used by the CE. This precaution ensures that test tracks are protected. The remainder of the CE disk cartridge is erased and may be written upon for test purposes.

2.9.7 Machine Adjustments Using CE Disk Cartridge

2.9.7.1 Head Tracking

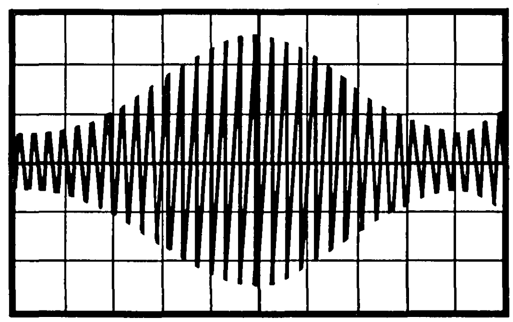
Each read/write head is adjusted so that it is positioned over master track 100 on the CE disk cartridge. This assures that the read/write head is optimally positioned over corresponding tracks on different disks to read any data disk cartridge.

The master track consists of a single eccentric track, part of which is written outboard from the center of track 100 and the other part written inboard from the center of track 100. Since fringing of this track into tracks 99 and 101 takes place, records should not be written on tracks 99, 100, and 101.

The eccentric track is written with a clock pattern of all zeros at a frequency of 720 kc. Both read/write heads are adjusted to obtain equal amplitudes for the envelopes developed.

When a read/write head is positioned to read equal amplitudes of the eccentric track, the scope pattern shown in Figure 2-15, View B will be present. This

5 MS/Div



A Approximate wave shape when head approaches master track 100

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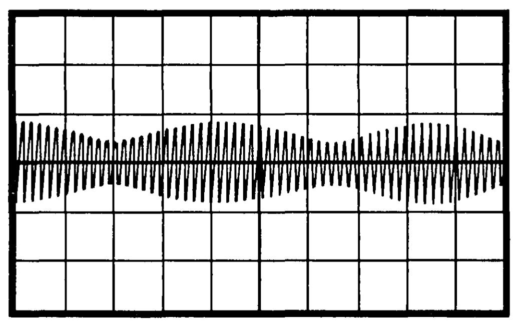

B Wave shape when head is properly adjusted on master track 100

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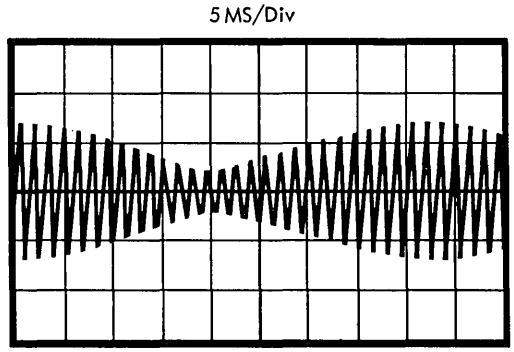

C Approximate wave shape when head is positioned beyond master track 100

26126A

Figure 2-15. Signal Patterns for Head Alignment Adjustment pattern is generated when the left erase pole tip sweeps over the track for 1/2 revolution of the disk and the right pole tip sweeps over the track for the other 1/2 disk revolution.

If a slight misalignment exists, the track will sweep more under one leg than the other, and only one envelope will show (Figure 3-15, View A), or two envelopes may be present as shown in view C.

If a very bad misalignment exists, no signal (only noise) will appear on the scope.

A special CE oscilloscope adapter is required to connect the erase winding into the preamplifier of the read circuit.

2.9.7.2 Index Timing

Disk cartridges containing the same data format can be used interchangeably with different machines; however, each machine must be indexed with a common point on the disk to ensure circumferential alignment of read/write heads with sectors on the disk.

The CE cartridge is used to provide a reference timing signal for aligning each read/write head to read and write at the beginning of a sector record field.

Index timing is adjusted by the use of master track 095 of the CE disk cartridge. A burst of bits and a timing pulse is displayed by this track (Figure 2-16). The time delay between the timing pulse and reference burst for an all bits pattern must be within 30 ±5 microseconds. The sector transducer is positioned radially about the spindle to accomplish the required time delay.

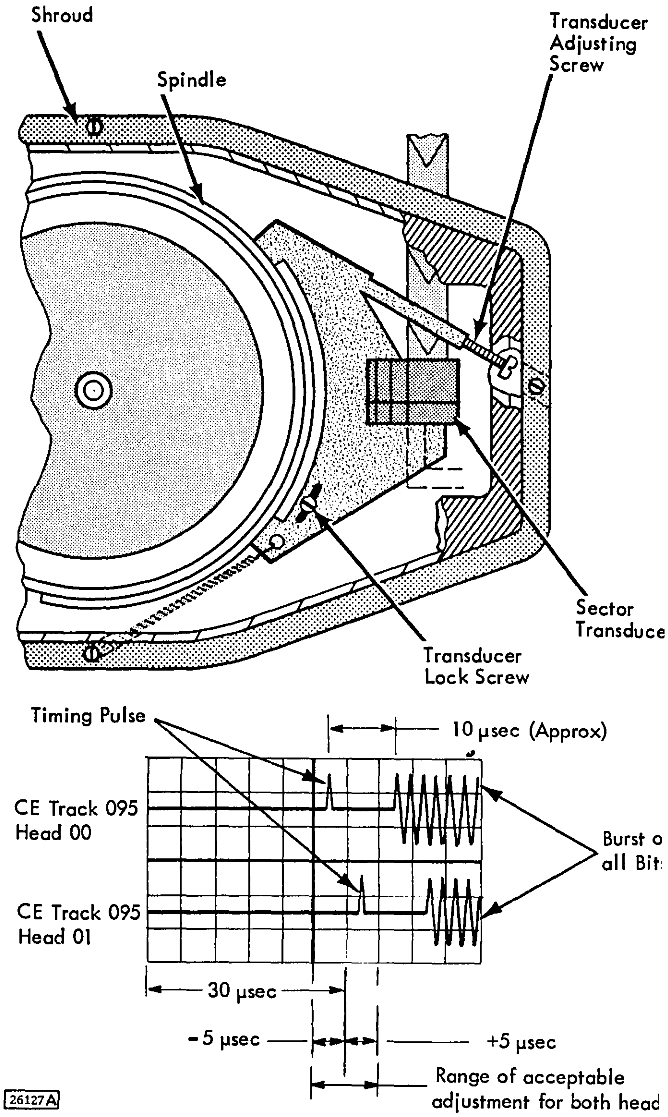

Figure 2-16. Index Timing Adjustment

3.1 COMMUNICATION LINES

- Eight input and eleven output communication lines are connected between the single disk storage and system control unit.
- Some of the lines establish machine status for demand-response commands by being active or inactive.
- Other lines provide information in the form of pulse signals which establish timing and control of read/write data.

Description

The communication lines (Figure 3-1) effect operation of the single disk storage by a demand-response command concept. The signal levels are at +3 volts and ground levels to denote an active or inactive status of the machine. Some of the communication lines from system control circuits function to condition internal circuits of

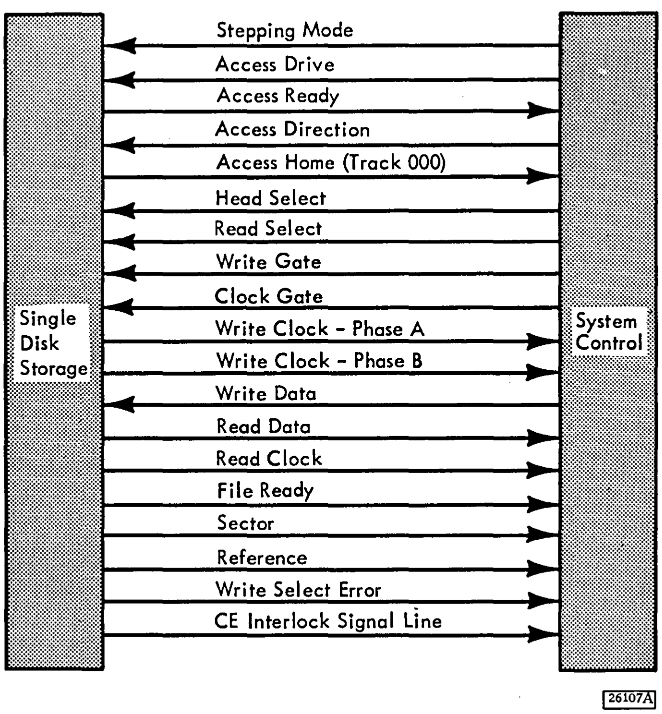

Figure 3-1. Communication Lines

the machine so that the machine responds to a given system command.

The machine output communication lines provide a status signal to system control to confirm that it is conditioned to respond to commands.

Other input and output communication lines provide information in the form of pulse signals which are at various frequencies. These lines function to produce timing signals and reference signals which are used to control read/write data.

3.1.1 Input Communication Lines

- Input communication lines originate at system control circuits to provide commands to the machine.

The input communication interface is composed of eight lines whose signals originate in the system control.

3.1.1.1 Stepping Mode

When this line is held at +3 volts, the carriage move two tracks each time an access drive pulse is received. When held at ground, the carriage moves one track each time an access drive pulse is received. Selection of the proper detent is accomplished by the internal circuits.

The state of this line must be selected within 1 ms following the leading edge of the access drive pulse and must remain in the selected state until after the access ready line drops from +3 volts to ground so that detenting occurs for the selected step mode.

3.1.1.2 Access Drive

This negative pulse is sent to the machine whenever carriage movement is desired. This signal must not be sent to the machine until the access ready condition is again active after a previous drive pulse.

The drive pulse must be from 1 μs to 3 ms wide for proper machine operation.

3.1.1.3 Access Direction

The state of this line indicates the desired direction of motion during accessing. For proper file operati this line must remain in the proper state from the time of the access drive pulse until the access ready signal drops from +3 volts to ground.

When the direction line is at +3 volts, forward direction of the head toward the spindle is indicated. A ground level indicates reverse direction away from the spindle.

3.1.1.4 Head Select

The state of this line indicates which head is selected. When the level is +3 volts, head zero is selected, and when the line is at ground level, head one is selected.

3.1.1.5 Read Select

Whenever this line is at ground, the machine is in a read mode and the read data and read clock conditions are available on their respective lines. When the read select line is held at +3 volts, no output is found on the read data and read clock lines.

3.1.1.6 Write Gate

This line controls the flow of write current to the recording heads and write driver circuitry. For proper file operation, this line must be operated in close coordination with the write clock gate line.

When this line is held at +3 volts, the write and erase circuits are completely disabled and the machine will not accept information on the write data line.

When this line is at ground level and the write select error line is at +3 volts, the write and erase circuits are turned on.

3.1.1.7 Write Clock Gate

This line controls the write clock and works in conjunction with the write gate line to ensure proper write circuit operation.

When this line is held at +3 volts, the write clock is prevented from running and write clock-phase A is held at +3 volt level. Write clock-phase B is held at ground.

When the clock gate line is held at ground, the write clock is allowed to run as described below.

3.1.1.8 Write Data

Using the write clock signal as timing, write data is generated by the host system and is used by the machine to control the write-driver circuits. Either phase of the write clock line may be used for reference provided the system is consistent within a given sector.

Each change of state of the write clock corresponds to a possible flux reversal on the disk surface. When the write data line is held at +3 volts, nothing is written on the disk surface (which is an invalid representation of data in double-frequency recording). When the write data line is held at ground level, a flux reversal is written for each transition of the write clock which records a pattern of repetitive binary ones.

In order to write double-frequency information it is necessary that the write data line be at ground level during the negative transitions of the write clock. This condition records the required clock flux reversal in each bit cell. In order to write a data flux reversal on the disk, the write data line must held at ground level. A binary zero (no data bits) is recorded when the write data line goes from ground to +3 volts within 0 to 350 ns following a negative transition of the write clock line. The line must drop to ground level within 0 to 350 ns following the positive going transition of the write clock in order to properly record the following clock flux reversal.

3.1.2 Output Communication Lines (Figure 3-1)

- Output communication lines originate from the machine to provide machine status information to system circuits.
- Signals developed by the machine enable the system to initiate commands for machine response.

Eleven output lines, (Figure 3-1) whose signals originate in the single disk storage provide inputs to the system.

3.1.2.1 Access Ready

The access ready signal is transmitted to the host system upon completion of an access motion. The access ready line drops from +3 volts to ground about 5 ms following an access drive pulse. The signal rises from ground to +3 volts when the carriage is ready to move again.

The maximum time from an access drive pulse to access ready is 15 ms.

3.1.2.2 Access Home

A switch is actuated whenever the carriage is at home or track 000 position. This switch controls a line which is at +3 volts when the carriage is detented in any of the track positions 001 to 203 and is grounded when the carriage is detented at home. The purpose of this line is to provide a reference point to system control to locate the carriage.

This line is formed directly from the output of a microswitch and is subject to jitter and bounce as it transfers during an access cycle into or out of home. Care should be taken to test for home position only when the carriage is fully detented.

3.1.2.3 Write Clock - Phase A

The machine circuits provide a 720-KC square wave as a write clock to strobe data out of the host system. This signal is generated by a crystal-controlled oscillator and is accurate to better than 0.1 percent. The nominal period of the square is 1.389 μs.

3.1.2.4 Write Clock - Phase B

The Write Clock - phase B signal is the same as phase A above, except that it is of opposite phase (i.e., when phase A goes positive, phase B goes negative, and vice versa).

3.1.2.5 Read Data

Each binary one recorded on the disk causes one pulse on the read data line. A recorded binary zero (clock pulse) causes no output. The read data pulses are negative going and are 400 ±100 ns wide.

3.1.2.6 Read Clock

The read clock consists of negative going pulses which are 400 ns (±100 ns) wide and nominally spaced 1.389 μs apart.

It should be noted that read clock and read data pulses are interleaved in time. Due to the interaction of the magnetic patterns on the disk surface, considerable variation may be found in the separation of data and clock pulses.

3.1.2.7 File Ready

This line is active at ground level when the file is in a ready state. The following conditions prevail in the ready state:

1. Disk is at full rotational speed.
2. Heads are loaded against the disk.
3. No write select error condition exists.
4. The 1.5-minute delay after turning on the drive motor has elapsed.

If these conditions are not met for any reason, the file ready line becomes inactive and has a +3 volt level.

3.1.2.8 Sector

Sector pulses are provided to assist in formatting data on the disk. There are eight sector pulses equally spaced 5 ms apart. These negative going pulses are 160 μs (±25 percent) wide.

3.1.2.9 Reference

One reference pulse is generated each revolution of the disk. This pulse follows one of the sector pulses by approximately 600 μs and is 160 μs (±25 percent) wide.

3.1.2.10 Write Select Error

This line is available to the system as an indication of a write circuit failure. It is a latched line so that the error indication will persist if the failure is of an intermittent nature. The write select error line is set and latched to ground level whenever either of the following conditions exist:

1. Write gate line is at ground and write clock gate line is at +3 volts which prevents oscillator from being turned on.
2. Both heads are selected for writing simultaneously.
3. Short exists between coils of the read/write head or between a coil and ground.

This line is reset by removal of power from drive motor to stop the disk.

3.1.2.11 CE Interlock Signal Line

The CE interlock CPU signal line connects all signal outputs from the machine to the CPU control circuits. The CE switches on the machine are inoperative while the CE interlock signal cable is connected between the machine and system control circuits. The CE interlock CPU signal line must be connected to +6 volts through a 150-ohm, 1/2-w resistor in the system control circuits to achieve this result. When the signal cable is disconnected from the control unit, the CE switches are activated, permitting manual operation of machine access circuits independent of the CPU.

3.1.3 <u>Home Drive Line</u>

The home drive line (at +3 v level) is a part of the internal machine circuitry. This line becomes active whenever the file ready line becomes inactive, while the access ready line remains active, with the carriage at any position other than home (track 000). The home drive line remains active until the carriage is accessed to home position where both, the access ready line and home drive line, become inactive.

3.2 BASIC MACHINE OPERATIONS

- Attain file ready status to accept commands from CPU control.
- Provide signals to CPU for file ready, access ready, and format information for reading or writing of data.
- Respond to CPU commands for accessing to a given track location.
- Respond to CPU commands for reading and writing of data on the selected track.

Description

When power is available from the CPU, all voltages used by the machine are developed at the system attachment circuits and sent to the machine. If a disk cartridge is inserted, and the receiver handle is raised and locked, the drive motor can be energized. After heads are loaded, a file ready status signal is supplied to the CPU. Internal logic in the machine for read/write safety and interlock circuits produce a read/write select error signal to the CPU if an incompatible condition exists in operation. Commands from the CPU cause the machine to access to a given track location, to read or write data on the disk.

3.2.1 Power on Sequence to Attain File Ready Status

- Ac and dc power is present at machine when CPU power is made available.
- Blower system operates from AC power.
- File ready signal is supplied to system control circuits to indicate machine status for receipt of and response to commands from CPU.

ŀ.2.1.1 CPU and System Control Interface

:he machine receives power from attachment and ystem circuits. Dc power of +3V, -3V, +6V and +48V s present. Ac power of 115V, or 208/230V, at 60 cycles 208/220V at 50 cycles) is present to operate the blower ystem.

With the CE interlock CPU signal cable connected, :E switches are disabled so that accessing can be complished by CPU commands. Disconnecting this able places the machine off line and permits manual peration of the CE switches to access and read data.

.2.1.2 Application of Power to Drive Motor

Raising and locking receiver handle after inserting cartridge permits drive motor to be energized and activates interlock circuits.

90-second timer starts as disk comes up to speed.

At 70% of speed, 30 rpm level detectors conditions head-load hold current.

hen ac power is applied to the drive motor, the caridge in place switch (made) and the cartridge lock vitch (made) cause the interlock circuits to deıergize the cartridge lock solenoid so the the receiver ındle becomes mechanically latched to effect an interck condition. (See Maintenance Diagram Manual, ›wer on Sequence Chart 501.) This interlock condi›n prevents removal of the cartridge from machine ıile drive motor is energized, and the 90-second ner begins operating.

When the motor start switch is made, the start relay is picked along with initializing the pick to the time delay relay. The start relay in turn completes the circuit to the motor relays and drive motor. When the motor reaches full speed, the motor relay drops, opening the start windings to remove current. After the disk comes up to speed, eight sector pulses and a single reference pulse are produced for each revolution of the disk. When 70% of full disk speed is detected by the interlock logic circuits (composed of the 30 RPM, and 70% speed-detection latch network), a head-load hold current (400 ma) is conditioned at the head-load solenoid. The write select error communication signal line becomes inactive (+3 volts) when the full disk speed of 1500 rpm is reached. After the 90-second timer stops, the disk temperature is stabilized with that of the machine, and read/write heads can be loaded onto the disk.

3.2.1.3 Loading of Heads

- 90-second timer stops, head-load pick current is applied while disk is at full speed.
- Heads become loaded, pick current is dropped, and head-load hold current maintains heads loaded condition.
- File ready condition is established after heads become loaded.

After the 90-second timer has timed out +48 volts is applied to pick the head-load solenoid which causes operation of the head-load mechanism. The head load mechanism activates the head-load switches to that the pick current is dropped and the 400 ms head-hold current retains the solenoid in the energized condition to maintain head loading. After a 40 ms delay, the file ready communication line (at ground level) is made available to system control to establish that the machine can be used for processing of data.

3.2.2 Sequence for Single Step Access Cycle Figures 3-2a and 3-2b)

3.2.2.1 Signals Developed by the Machine for Access Cycle

- File ready signal supplied by the machine provides a status indication that machine can be accessed by CPU.
- Access ready signal supplied by machine provides an indication to control circuits that carriage is ready to be moved.

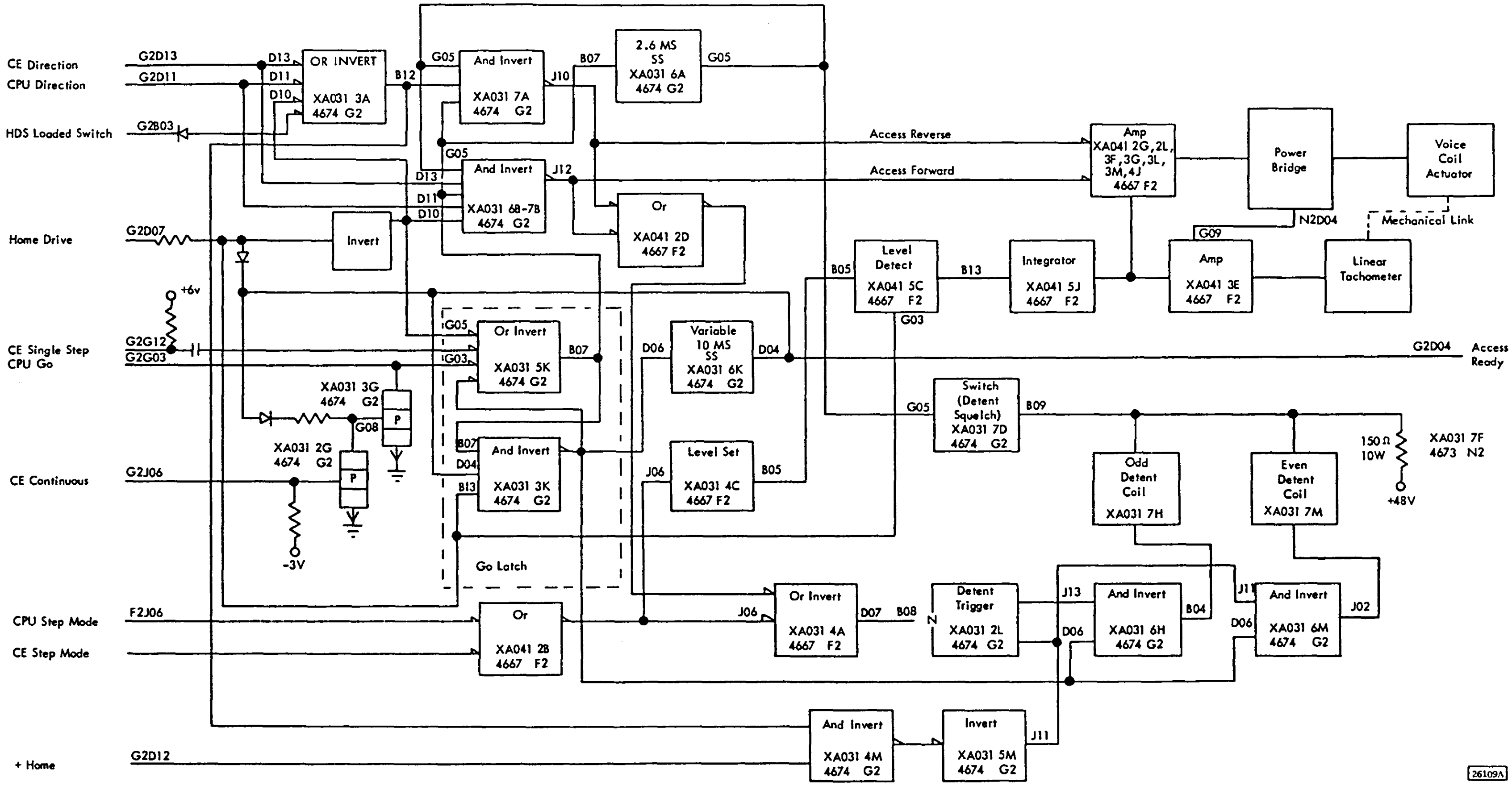

Figure 3-2a. Access and Detent Logic Flow Diagram

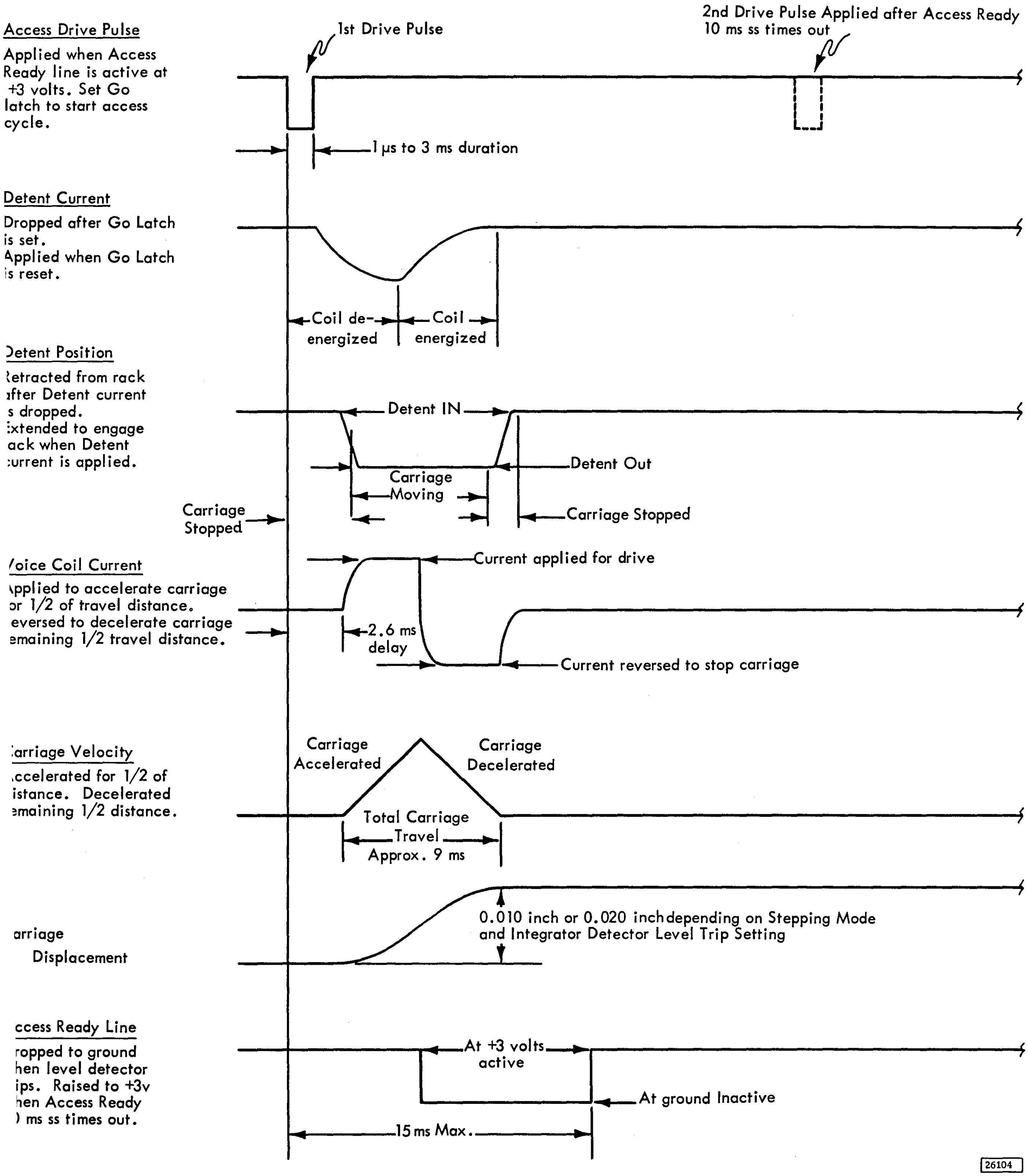

Figure 3-2b. Timing for Access Control Circuits

- Access home signal supplied by machine provides an indication to control circuits of carriage location relative to home position. (Signal is at ground level for home position and +3 v for other positions.)

A total of three communication signals is produced by the machine to accomplish an access cycle. The file ready communications signal produced by the machine is active at ground level (inactive at +3 v).

Two additional communication signals are produced by the machine and supplied to system control: the access ready signal, active at +3v (inactive at ground) indicates to control circuits that carriage can be accessed to another track location; the access home signal (at ground level for home; +3v for other locations) indicates the position of carriage to control circuits.

3.2.2.2 Signals Developed by System to Accomplish Access Cycle

- Command signals from control circuits cause the carriage to move.

- Access direction (forward or reversal), stepping mode (10 or 20 milli-inches), and access drive (pulses) constitute command signals supplied by the control circuits which initiate the accessing cycle.

The machine accomplishes an access cycle by response to three communication command signals sent from control.

The access direction signal (+3v forward, ground for reverse) determines which direction the carriage moves upon receipt of a drive pulse.

The stepping mode signal (+3v for 20-mil step, ground for 10-mil step) determines the distance, that carriage moves upon receipt of a drive pulse. This signal sets the integrator detector level to trip during carriage displacement.

The integrator voltage level-set and level - detector circuits become conditioned to de-energize the detent magnet and reset the go latch during the access cycle.

The access drive pulse communication signal initiates the start of an access cycle. This negative pulse sets the go latch wherever the access ready line is active (+3 v).

3.2.2.3 Access Cycle Operation (Figure 3-2)

- Internal logic of the machine responds to system commands to effect carriage positioning.

- Access time is 15 ms for either a 10 or 20 mill step.

- A 20 ms delay occurs at the final track position which is initiated by system control circuits.

Operation of the access cycle is initiated by a drive pulse from the CPU. See Maintenance Diagram Manual, Single Step Access Flow Chart 603.

A negative access drive pulse from system con trol circuits immediately sets the go latch in the access logic of the machine. Setting of the go latch causes detent current to be dropped, and starts the 2.6 ms single shot signal which remains active while the detent is retracted from rack on carriage

After the 2.6 ms single shot signal is timed out, the voice-coil actuator becomes energized wit drive current in a given direction which causes the carriage to accelerate.

Carriage motion is sensed by the tachometer circuit which produces an output voltage to charge a capacitor in the integrator level circuit. When the integrator circuit is charged to the trip level established by the stepping mode, the level detecto trips to reset the go latch.

When the go latch becomes reset, the access ready 10 ms single shot signal is started, and the access ready line becomes inactive (at ground leve

The detent magnet becomes energized so that the detent moves toward the rack. The voice coil becomes energized with reverse current to effect deceleration of the carriage motion.

Carriage motion is again sensed by the tachometer which produces a voltage proportional to the carriage velocity that is fed back into the voice coil to effect dynamic braking of the carriage. When the carriage velocity decreases to approximately zero, the detent engages and bottoms in the rack to position the carriage at the new track location.

The access ready 10 ms single shot signal becomes timed out, and the access ready line again becomes active (at +3 volts) for receipt of another access drive pulse from the CPU. Which completes the single-step access cycle.

The repetitive cycles of accessing and detenting are accomplished incrementally for each successive step, at 15 ms time intervals until the required track address established by the CPU is reached.

Approximately 20 ms time delay occurs at the final track position to allow for diminishing of carriage vibrations before the reading or writing of data takes place. This delay function originates in the system control circuits.

3.2.3 Power Off Sequence for Shutdown of Machine

- Removal of power from drive motor causes heads to unload.
- File ready communication line becomes inactive.
- Home drive internal access logic line becomes active and carriage moves to home position.
- Cartridge interlock circuits become de-activated when disk speed is reduced to 30 RPM to permit removal of cartridge from machine.

'escription

he power-off sequence is initiated when ac power ; removed from the disk drive motor. See Mainte-ance Diagram Manual, Power Off Sequence Chart)2. DC power from the CPU at +3V, -3V, +6V, ıd +48V levels will still be present within the ma-ıine. Also, ac power will be present within the ; electronics box.

When power is removed from the disk drive otor, head-load hold current (400 ma) is removed om the head-load solenoid. The head-load sole-ɔid deactivates the head-load mechanism causing ead/write heads to unload. Simultaneously, the le ready line becomes inactive (at +3v level) and home drive line in the machine logic circuits be-ɔmes active, while the access ready line remains tive (+3v level). If the carriage is detented at y track location other than home position, a plus-vel drive pulse, generated by internal circuits of e access logic causes the carriage to access to me position. Accessing and detenting are accom-ished by 20-milli-inch incremental steps until e carriage contacts the home switch which de-tivates the home drive line.

3.2.3.1 Home Drive Access Cycle

- Internal access logic circuits produce drive pulses which cause carriage to access to home position.
- Carriage moves in 20-mil incremental steps in reverse direction until home position is reached.

The home position switch is normally open, and while the carriage is positioned at any track location other than home, this switch presents an active (+3v level) home drive line to the access logic card of the machine. Positive pulses which are inverted by the access logic are applied to this line to initiate the access-detent cycle, which continues until the carriage arrives at home position to close the switch.

The integrator level set and level detector circuits are conditioned to de-energize the detent magnet and reset the go latch for a stepping mode of 20 milli-inches. Also, the access direction line is set for reverse so that carriage always moves toward home position.

When the access ready line is active (+3v level) while the file ready line is inactive, a drive pulse is applied to the home drive line by the access logic circuits. The go latch becomes set, and a 2.6 ms single-shot delay signal is started. The detent magnet becomes de-energized and the detent retracts from the carriage. After the 2.6 ms single-shot signal has timed out, a drive current is applied to the voice-coil actuator and the carriage is accelerated toward home position. The tachometer senses carriage velocity and produces an output voltage which charges a capacitor in the integrator circuit to the 20 milli-inch trip level.

When the trip level is reached (which is approximately one-half of the total carriage displacement), the go latch is reset, and the access ready line becomes inactive (at ground level).

The access ready 10 ms single-shot delay signal is started, causing the detent magnet to become energized so that the detent extends toward the carriage. The voice-coil actuator becomes energized so that the detent extends toward the carriage. The voice-coil actuator becomes energized with reverse current to effect deceleration of the carriage motion.

Carriage motion is again sensed by the tachometer which produces a voltage proportional to the carriage velocity that is fed back into the voice coil to effect dynamic braking of the carriage.

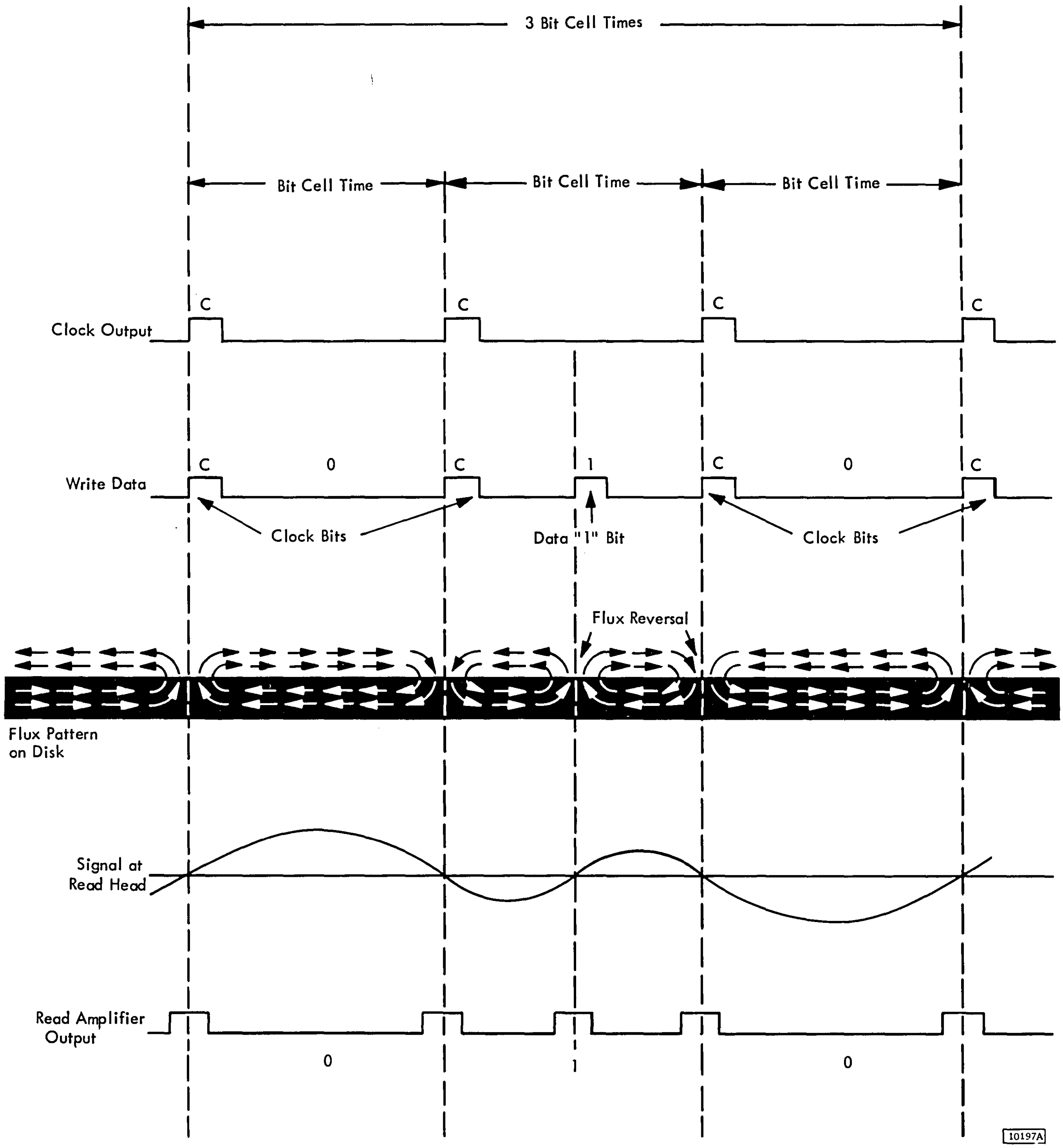

Figure 3-3. Double Frequency Recording Flux and Pulse Relationship

When the carriage velocity decreases to approximately zero, the detent engages and bottoms in the rack to position the carriage at the new track location. The access ready 10 ms single-shot becomes timed out, and the access ready line again becomes active (at +3v) for receipt of another, drive pulse from the access logic card which completes the home drive access cycle.

3.3.3.2 Deactivation of Cartridge Interlock Circuits

After the carriage is restored to home position, sector pulses continue to be generated by the revolving disk. When the 30 rpm speed detection latch becomes reset, as a result of a change in frequency of sector pulses caused by the disk speed slowing down, the cartridge-lock solenoid becomes energized. Energizing of this solenoid releases the mechanical latch on the receiver handle, which permits the operator to lower the handle and remove the cartridge.

3.3 READ/WRITE OPERATIONS

- The double frequency recording method is used in reading and writing of data.
- Read/write operations are accomplished by the read/write head which is sensitive to the flux patterns developed at the ring gap.
- During a write operation, a bit is recorded on the disk whenever the coils of the read/write head are switched by the write driver.
- During a read operation, a bit is sensed on the disk whenever current direction induced in the coil winding is reversed as a result of a change in polarity at the ring gap.

3.3.1 Double Frequency Recording

- A basic clock-pulse frequency signal is synchronized with interspersed data pulses to produce a single composite signal at the read/write head.
- The composite signal presents either a zero-bit condition or a one-bit condition for each bit-cell time generated by the clock.

Description

The single disk storage uses the double frequency method of magnetic recording (Figure 3-3). This method makes use of a clock frequency to establish the basic bit-cell timing cycle. The insertion of a data pulse between clock pulses in a bit-cell period, produces a composite read/write signal which uses clock pulses only for a zero-bit indication, and data pulses for a one-bit indication.

A zero bit-cell-time (clock pulse only) produces a single change in direction of the flux pattern. A one bit-cell-time (data pulse located between two clock pulses) produces a double change in direction of the flux pattern. In either case, the clock signal causes a change in direction of magnetism from plus-to-minus, or minus-to-plus polarity which effects the storage of a bit. Because both clock and data information are synchronized on a composite signal, double-frequency recording is sometimes referred to as self-clocking.

In double frequency recording, a clock bit is always inserted at the begining of each bit-cell-time (Figure 3-3) to establish the basic recording frequency. A data bit is inserted between clock bits (at twice the frequency) so that the data bit results in two flux reversals within a single bit-cell-time. If the data bit is not present, a single flux reversal occurs in a bit-cell-time.

The recording head is a split-ring core containing a coil winding so that a magnetic field in a given flux direction prevails at the ring gap while the coil is energized. When current flows through the coil, the flux induced in the ring establishes a fringe flux at the gap (Figure 3-4). As a magnetic recording surface passes by the gap, the fringe flux magnetizes the surface of the disk.

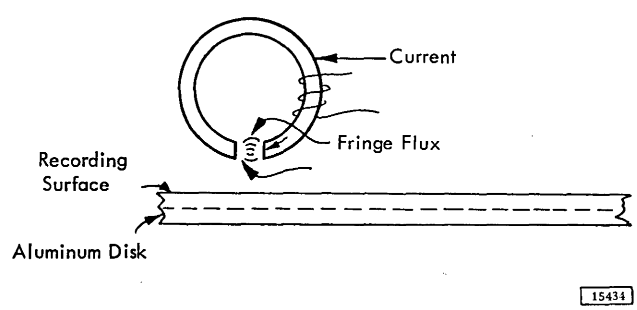

Figure 3-4. Basic Ring Head

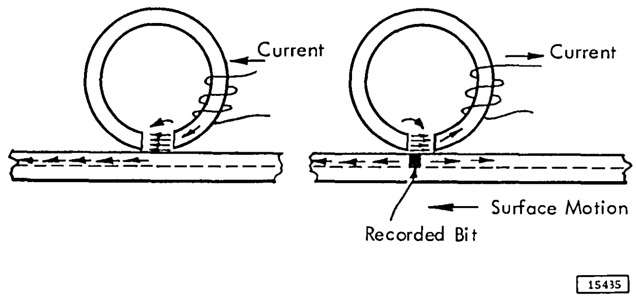

Figure 3-5. Reversal of Flux while Recording

During a write operation, a bit is recorded when the flux direction in the ring is reversed by switching between coils of the read/write head. The fringe flux is reversed in the gap and hence the portion of the flux flowing through the recording medium is reversed. If the flux reversal is considered instantaneous in comparision to the motion of the recording surface, and the gap is observed at the moment of reversal, it can be seen that the portion of the surface that just passed the gap is magnetized in one horizontal direction while the portion directly under the gap is magnetized in the opposite direction. Between these two areas, the flux must reverse 180°; this recorded flux reversal represents a bit (Figure 3-5).

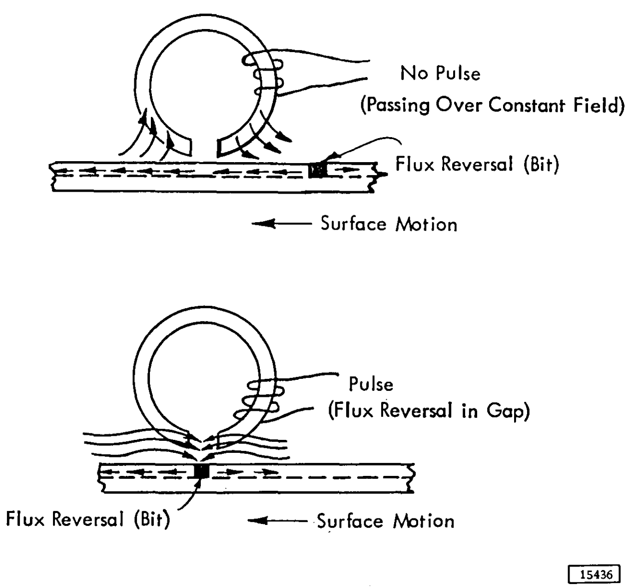

Figure 3-6. Reversal of Flux while Reading

During a read operation, the gap first passes over an area that is magnetized in one horizontal direction, and a constant flux flows through the ring and the coil. The coil registers no output voltage for this condition. However, when the recorded bit (180° horizontal flux reversal) passes the gap, the flux flowing through the ring and coil must also go through a 180° reversal. This means that the coil sees a change in flux which results in a voltage output pulse (Figure 3-6).

3.3.2 Read/Write Head

- The read/write head is a three-terminal device containing three coils.
- The machine writes a wide band (approximately 0.008 inch) then tunnel erases the recorded data to leave a narrow band (approximately 0.005 inch) on the disk.
- The tunnel erase feature provides for a larger gap between individual tracks.

Description

The read/write head used in the single disk storage is a three-terminal device containing three coils. One coil is used exclusively for magnetically erasing data from the disk. The remaining two coil are connected parallel to each other, and in series with the erase coil, and are used for reading and writing on the disk surface. The read/write head is designed with the read/write core ahead of a split-erase core (Figure 3-7).

This unique design (called tunnel erase) allows the head to write a band of data 0.008 inch wide the erase it to 0.005 inch wide. The difference in eras and write widths allow for minor deviations in head positioning during subsequent read operations and extends the gap between individual tracks.

The current through the write coil erases the old data as new data is recorded.

3.3.3 Head Selection (Figure 3-8)

- Accomplished by circuits of the system.
- Interlocked with read/write circuits to produc a write select error signal if heads are improperly selected.

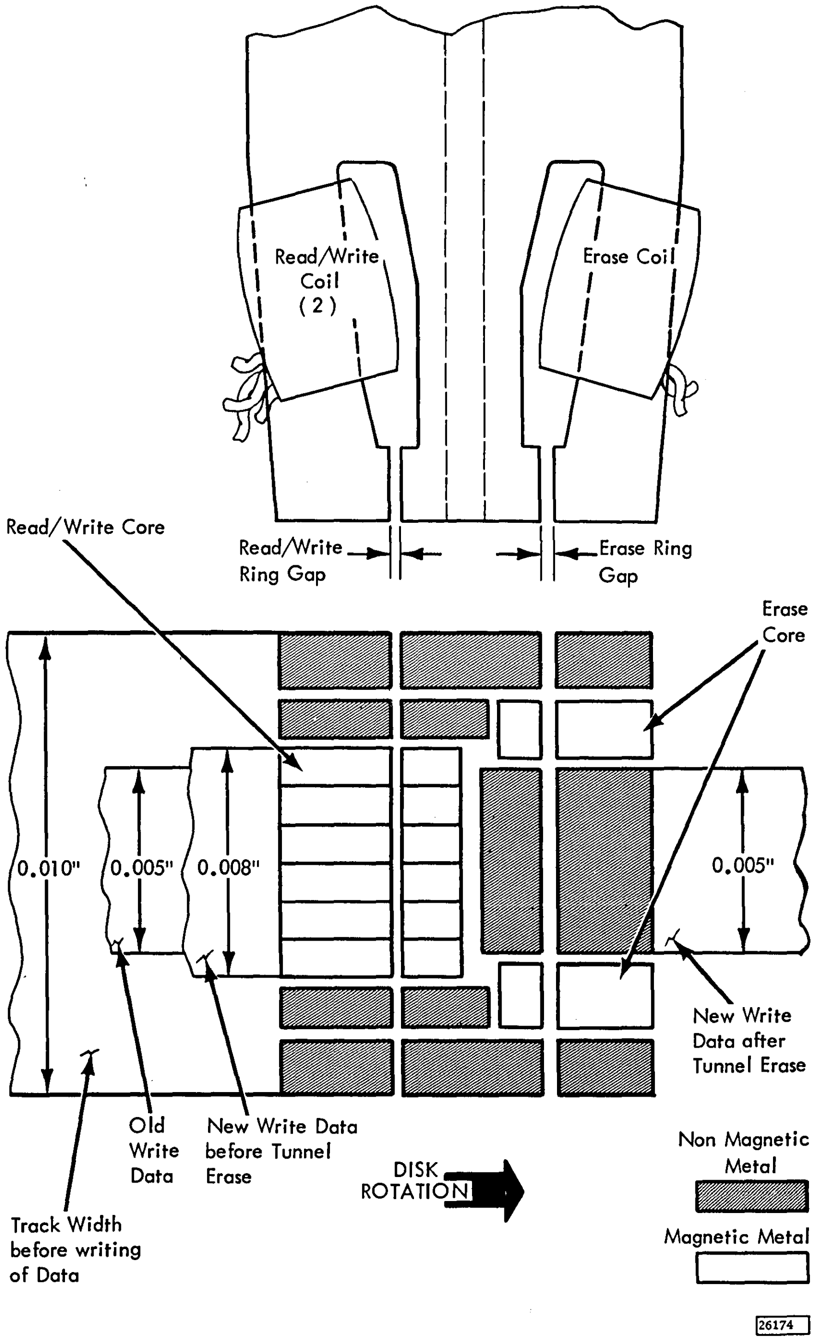

Figure 3-7. Magnetic Head-to-Disk Relationship

Description

The head select line provides for selection of head 0 or head 1 depending upon the state of the signal originating from system control. When the head select line level is up (at +3 volts), head 0 is selected. When the line level is down (at ground), head 1 is selected.

The head select line is interlocked by gated signals from the read select line, write gate line, write data line, and write clock gate line either of which can set the write lock latch to produce a write select error condition to the system if both heads are selected simultaneously for writing.

3.3.4 Safety Circuits (Figures 3-8 and 3-9)

- A write select error signal is supplied to the system whenever errors or malfunctions exist in read/write circuits.
- The write select error signal is produced by the write lock latch which becomes set.
- The write lock latch is reset by stopping the drive motor to reduce disk speed to 30 RPM, and then restarting the motor to allow the disk to come up to full speed.

Description

Signals from head select, write gate, and write clock gate input lines are ANDed to supply a write signal for each read/write head. All read/write safety circuits are coupled with the write lock latch (Figure 3-8) which is set when the following conditions prevail at gated outputs from read/write input lines:

1. Both heads are selected for simultaneous writing.
2. Write gate line is at ground (active) and write clock gate line is at +3 volts (inactive) so that oscillator is not turned on.
3. Short between coils of the read/write head or between a coil and ground which would cause excessive current to be drawn through the write resistor.

The latch is set at ground level to produce a write select error signal to the control system which removes the machine from a file ready condition.

3.3.5 Write Circuits (Figure 3-8)

- Information to be recorded is supplied to the machine via the write data line.
- The writing process is under complete control of the system circuits.
- Verification by the system of the record address is made by sector designation prior to the initiation of the write operation.
- The machine is conditioned to write when the write gate line and write clock gate line is at ground.

Description

When the proper head is selected and the write gate is established, (Figure 3-8) the write driver and the write and erase coils are receptive to data pulses. When the write gate is established, current flows through the write coil and causes all previous data to be erased even though no write data is transmitted.

Write data pulses are supplied from the control system to the write trigger. The write trigger flips with each pulse to provide on-off outputs to the write driver. With each flip of the write trigger, current flows in one half of the read/write coil and through the erase coil. The read/write coils and erase coil are connected so that each flip of the trigger always causes current to flow through the erase coil, but alternates between the read/write coils.

During the write process, the machine provides a write clock signal to the control system which is used as the timing reference. A 1.44 MC crystal-controlled oscillator is used to generate the basic write oscillator signal. A trigger divides this to a 720KC square wave which is sent to the control system as the write clock signal. Both phases of this signal are available to the system when the machine is operating in the write-gate mode. (In the read select mode, the write clock signal is not

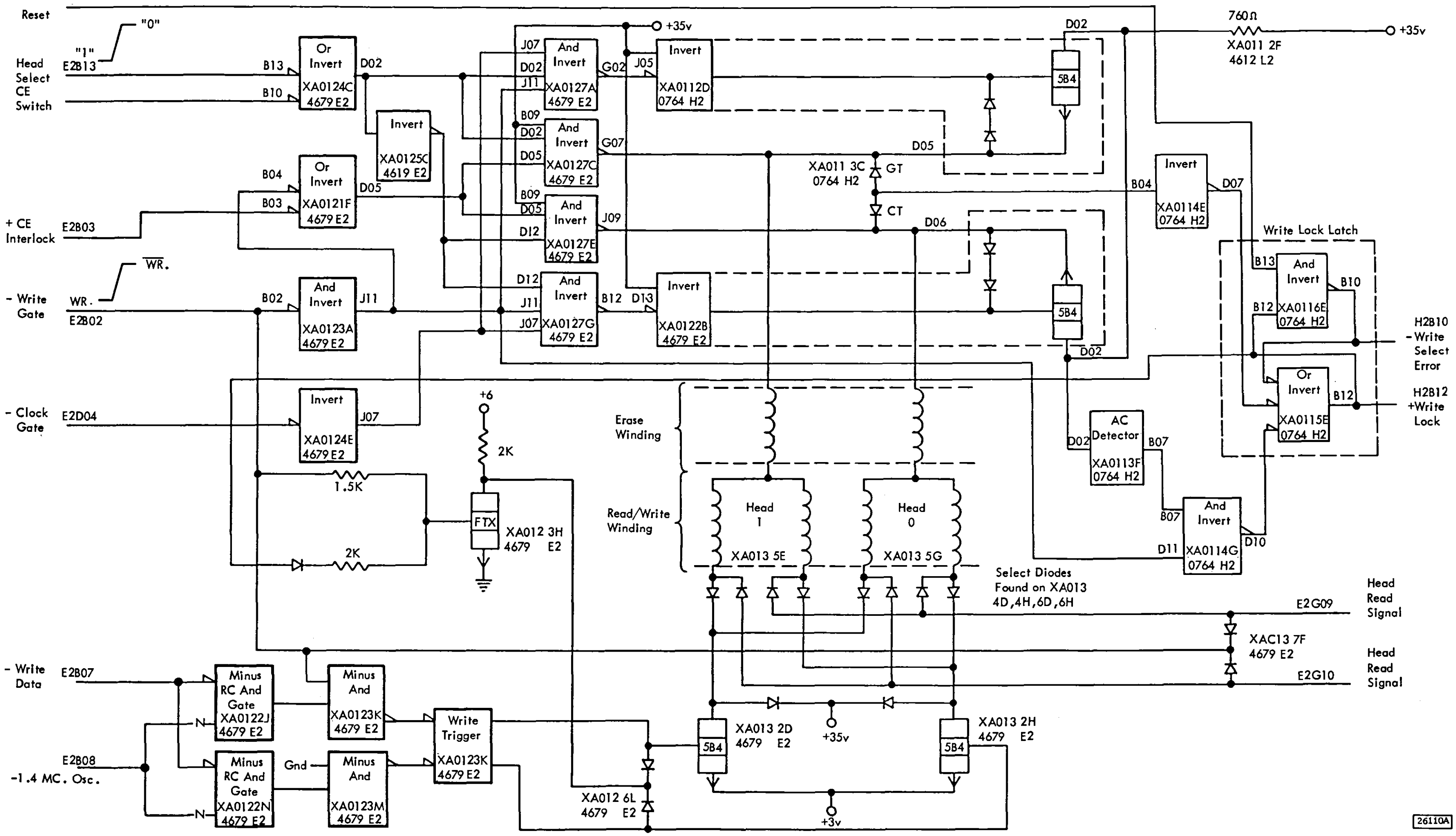

Figure 3-8. Write Driver Logic Flow Diagram

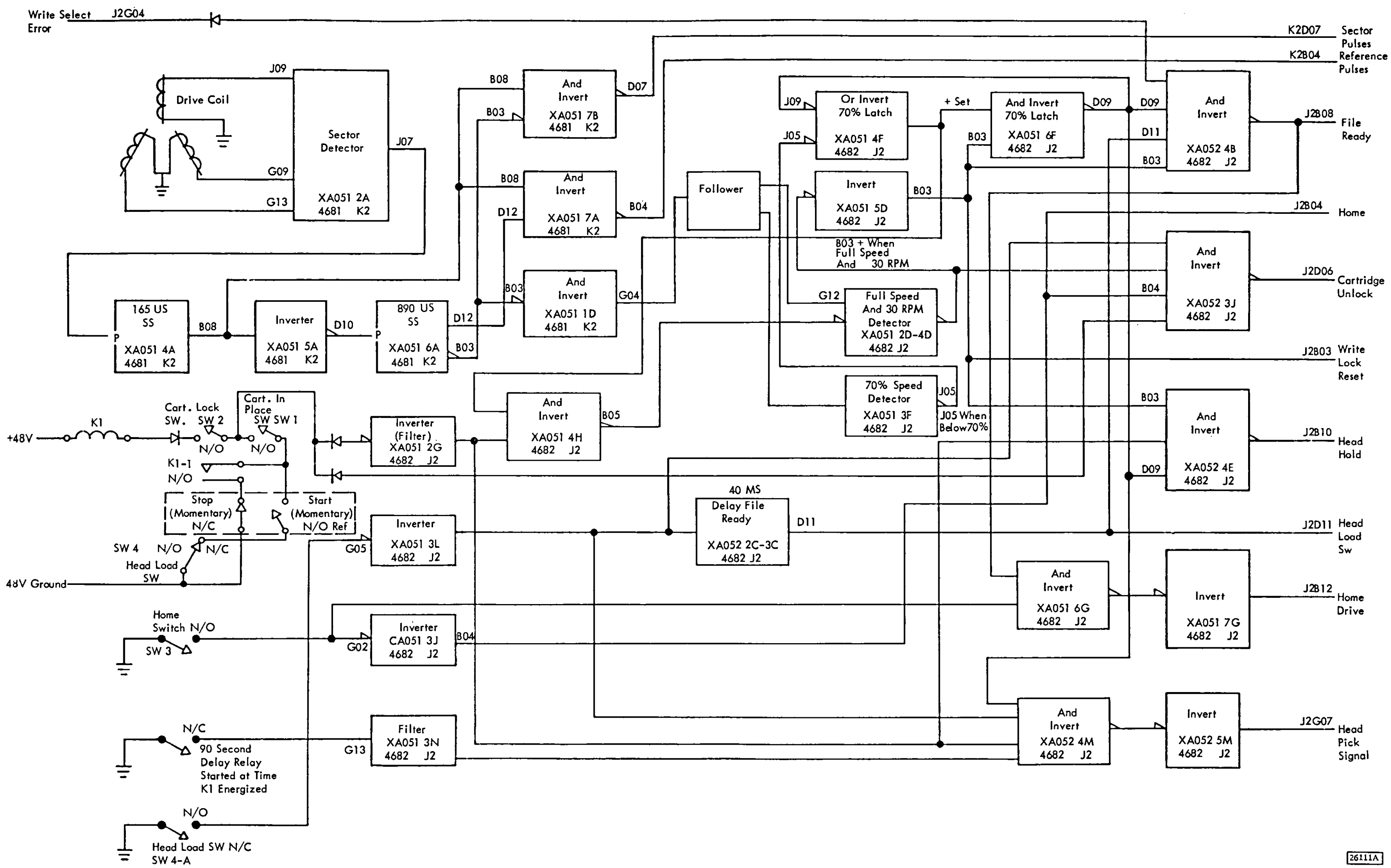

Figure 3-9. Sector Detector and Interlock Logic Flow Diagram

gated to the system, although the basic crystal oscillator continues to run.)

In order to properly record data, the control system must provide a write data signal which is used to gate the 1.44 MC oscillator signal to write circuits. When this line is held at ground level, a transition is written on the disk for each transition of the write clock, thus recording a pattern of repetitive ones. If the write data line is held at a +3-volt level, nothing is recorded on the disk. The circuits are designed so that when the write clock signal is used as an input to the write data line, properly coded repetitive zeros are recorded.

The oscillator signal within the machine is gated by the write data signal to drive the write trigger and write driver stage. The write current flows through the erase coil, and is then switched by the write driver between the two read/write coils to cause magnetic flux reversals, on the disk surface.

Because the core of the write coil is physically wider and placed in front of the erase core, a constant current through the write coil causes a width of 0.008 inch to be magnetized in a constant direction. The erase coil following the write coil erases part of the write pattern to leave a recorded band that is 0.005 inch wide (Figure 3-7).

Index pulses are transmitted to system control during the entire time that writing takes place. These pulses are used to control the start of timing for the recorded data.

Data integrity is maintained in the machine by the write driver circuits which will not allow erasures of data when any one component fails. Any time both heads are selected during a write operation, a safety latch is set, file ready condition is removed, and the write driver is turned off. The safety latch may be reset by stopping the drive motor and restarting, or by a Customer Engineer.

3.3.6 Read Circuits

- A read data command allows read data to be transmitted from the desired track and sector address to the processing system.
- The reading process is under complete control of the system control circuits.
- Machine is conditioned to read when a head is selected and the read select line is at ground.

Description

The read process uses the playback signal from the read/write coils as the input to a wide-band read amplifier.

A differential preamp is used to minimize the effects of electrical noise and bit shift in the head before the signal reaches the read amplifier. Since the read signal peaks correspond to the flux reversals on the disk, a differentiating stage of amplification is employed so that the zero crossing points of the signal represents the reversals. A filter is used to restrict the high frequency response of the amplifier and minimize the effects of high-frequency noise.

The signal is then amplified further in an overdriven amplifier stage where it is clipped and shaped into a composite pulse pattern containing clock bits interleaved with data bits. This shaped signal is then supplied to the input of the data separator.

The shaped signal received by the data separator circuit is decoded to separate data bits from clock bits, and form two communication lines. The read data line and read clock line provide for sending the separated signals to system control.

Read amplifier and data separator timing patterns are shown in Figure 3-10.

3.3.6.1 Read Amplifier Circuits

- Raw read data in the form of a sine-wave signal is supplied through a preamplifier to the read amplifier
- The read amplifier converts the sine-wave signal to pulses which are then supplied to the data separator circuit

The read amplifier circuit (Figure 3-11) receives differential input signals which range from 360 kc (all zero pattern) through 720 kc (all ones pattern). The read amplifier converts the differential signals to pulses at its output which represent data or clock pulses depending upon the frequency at the input. A separate SLT card provides this circuit function.

Output leads from the heads connect to the input of the preamplifier which is a part of the write driver and preamplifier SLT card. An approximate 3-millivolt output signal received from the read/write head, is boosted by the gain of the preamplifier, and is then supplied to the read amplifier.

The read amplifier consists of a filter stage differentiator stage, overdriven amplifier stage, and a bit detecting and shaping circuit (Figure 3-11) which provides the input to data separation circuits.

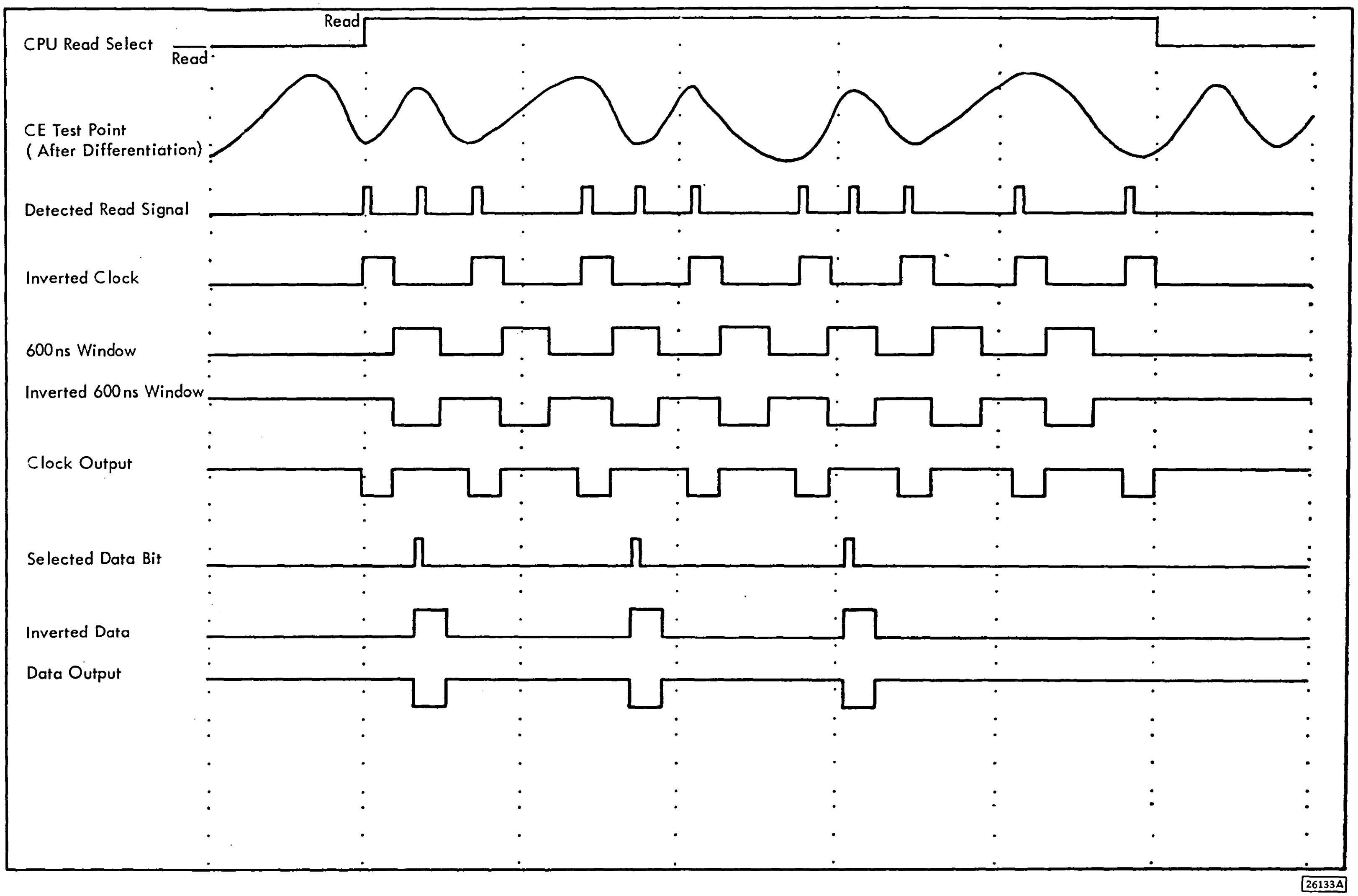

Figure 3-10. Read Amplifier and Data Separator Timing Chart

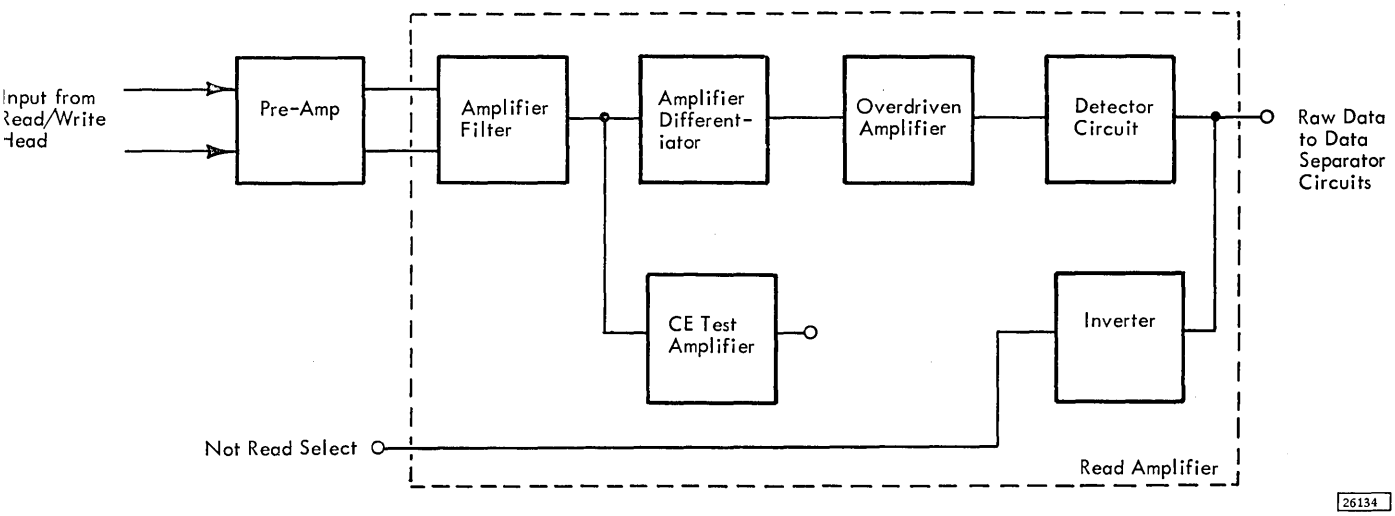

Figure 3-11. Read Amplifier Circuit Block Diagram

The actual read signal processing begins in the read amplifier SLT card. The amplifier filter stage receives a differential signal from the pre-amplifier. This circuit provides additional amplification, filtering, and detection of the read signal. The signal is single ended to succeeding stages.

The output of the amplifier filter stage is supplied to the amplifier differentiator stage, and a CE test amplifier. The output voltage level at this point (1.50 v minimum to 3.15 v maximum) varies with respect to the track being read. (A higher voltage prevails at the outside track than on the inside track).

The amplifier differentiator stage amplifies and shifts the signal approximately 60 degrees in time from the input resulting in data pulses which coincide with high and low points of the incoming signal.

The signal from the amplifier differentiator stage then passes through an overdriven amplifier stage which squares and amplifies the signal an additional amount.

The output from the overdriven amplifier is coupled to the detector circuit stage which detects all transitions in the square wave received from the overdriven amplifier. The output from the detector circuit stage, consisting of a train of inter-leaved clock and data pulses, is supplied as raw data input to the data separator circuits. This output is also coupled with an inverter which is used for test purposes to hold the output of the read amplifier at ground when not performing a read operation.

3.3.6.2 Data Separator Circuits

- The data separator circuits decode the signal received from the read amplifier to separate data from clock pulses.

The data separator circuit (Figure 3-12) receives the output of the read amplifier. This circuit accepts a train of interleaved clock and data pulses and separates the signal to provide two lines; a read data line, and read clock line to the control system. A single SLT card provides this circuit function.

The data separator circuit consists basically of three single shots connected as shown in Figure 3-12. Timing relationships are shown in Figure 3-10.

The input consists of a train of pulses with a nominal width of 200 ns. There are clock pulses present which are spaced 1.43 μsec, nominally (leading edge to leading edge), at all times during a read select mode. There may or may not be data pulses spaced midway between the clock pulses, nominally 715 ns after a clock pulse. The circuit distinguishes between a pulse spacing of 1.43 μsec and 715 ns to allow for all possible variations of these spacings. It then extracts and produces a separate output signal for all data pulses as the read data line. The clock pulses are similarily extracted and produced as an output signal for the read clock line. The separation of data pulses and clock pulses into individual signals is accomplished by synchronizing a single-shot signal on an all zero field (clock pulses only). Clock timing enables gating between pulses to permit data pulses to pass.

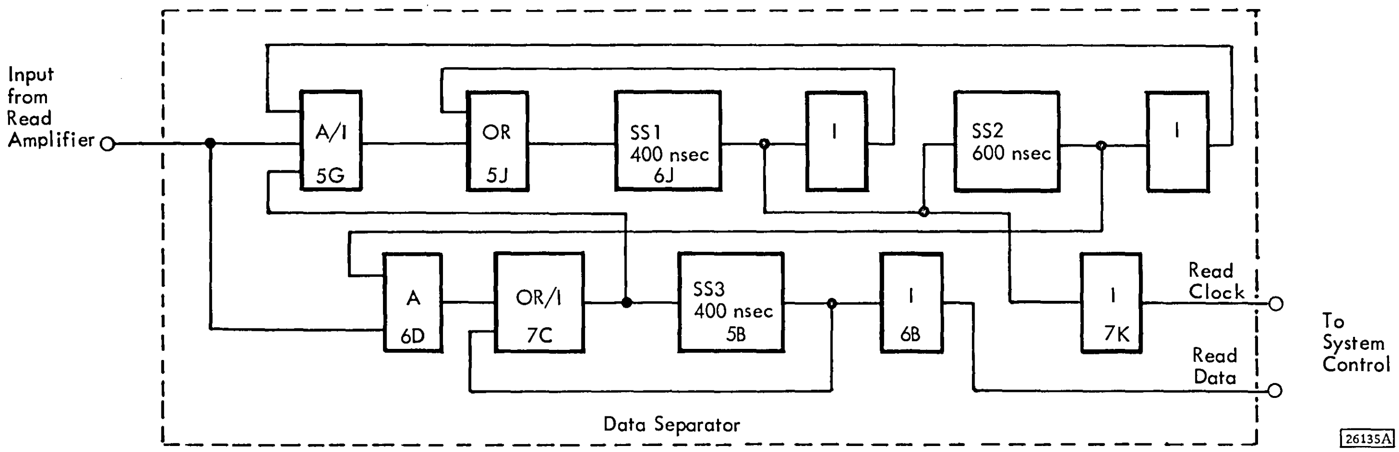

Figure 3-12. Data Separator Circuit Block Diagram

This separation of the signal (Figure 3-12) is accomplished in the following manner: A 400 ns single shot, SS1, is set by the leading edge of all clock pulses and its output is the clock output line. A second single shot, SS2, is set by the trailing edge of the pulse from SS1. SS2 is an adjustable single shot whose trailing edge is set at 1,000 ns after the leading edge of SS1. SS2 forms a 600 ns window or gate through which any data pulse can pass. These data pulses set SS3 whose output is the data output line. The input is blocked by SS2 or SS3 to prevent retriggering of SS1 by a data pulse.

Each binary one recorded on the disk causes one pulse on the read data line. A recorded binary zero (clock pulses) cause no output on this line. The read data pulses are negative going and are 400 ±100 ns wide.

The read clock signal consists of negative going pulses which are 400 ±100 ns wide and nominally spaced 1.389 μs apart.

3.4 READ/WRITE SYSTEM OPERATIONS

- Formatting is dependent upon using system.
- Eight sectors are available for each read/write head.

3.4.1 Data Format

The formatting of data on the disk cartridge is very flexible and allows the host system to specify a format. Sector pulses are provided to allow simple fixed record length recording to be used although more sophisticated techniques of variable length ma be employed if desired.

It should be mentioned that although the disk cartridges are physically interchangeable between all machines, differences in data format representa tion may prevent the interchange of data between different system types.

Figure 3-13 shows the general format of a fixed record occupying one sector.

Writing commences at the beginning of the sector to make maximum usage of the space availab A format field is recorded first consisting of an all-zeros pattern whose length is dependent on several factors. This is followed by a synchronizing field of at least four ones followed by one zero, and then data is recorded. The all-zeros pattern in the format field must be long enough to allow the read/write element to move into the position of the disk between sectors which has been fully erased.

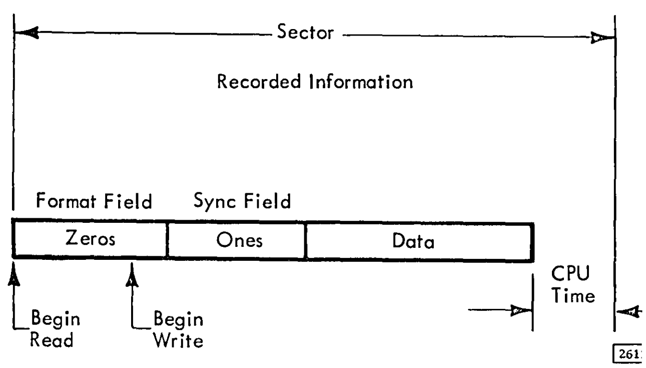

Figure 3-13. Format of Fixed Record Occupying One Sector

Additional zeros must be written so that read operations can always begin in a field of all zeros which has been properly erased.

Sufficient time must be allowed at the end of the data to allow the system to decide whether or not it must read or write the next sector. The time required varies depending on speed and instruction set of the CPU.

As an example of a fixed length record format, consider a system which uses four sectors per track. This sample format has not been optimized for maximum storage capacity, but rather for simplest control, and is arranged as follows:

Time from trailing edge of sector pulse to sync field	250 μs ±15%
Time from end of data to next sector	195 μs Min.
Length of sync field	One 20-bit word
Sector capacity	321/20-bit words
Total capacity of disk (200 Tracks)	513,600/20-bit words

More complex formats such as a fixed record length containing an address scheme, or a variable record length containing a count, key, and data field, are possible without modification to the machine.

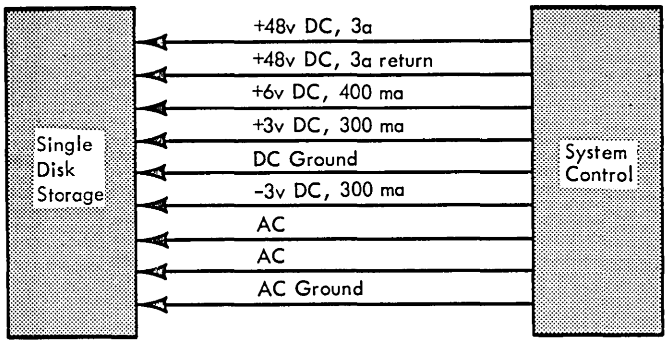

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Figure 4-1. Power Lines Interface

4.1 POWER REQUIREMENTS

- Power is obtained from system circuits.
- Three machine versions require separate combinations of ac power and frequency considerations.

Description

All power required by the single disk storage is obtained from system circuits. Input power lines to the machine are shown in Figure 4-1.

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

4.1.1 AC Input Supply Power

- Blower motor and disk drive motor operate from ac power input.

Three versions of the single disk storage contain the following type primary ac power inputs shown in Figure 4-2. Internal circuits of the AC box located on the front of the machine receive ac input power and distribute it to machine components.

4.1.2 DC Input Supply Power

- Signal lines control circuits and interlock circuits operate from dc power input.

DC input requirements for the single disk storage are contained in Figure 4-3. DC power is received by the machine at TB 1 located on the base plate at the rear of the machine from where it is distributed to machine components.

Machine Version	Use	Voltage (ac)	Tolerance	Phase	Frequency (CPS)	Current
Type I	Blower Disk Drive	115 115	±10% ±10%	Single Single	60 ± 1/2 60 ± 1/2	3 Amp, Start/1 Amp, Run 14 Amp, Start/1.5 Amp, Run
Type II	Blower Disk Drive	208/230 208/230	±10% ±10%	Single Single	60 ± 1/2 60 ± 1/2	2 Amp, Start/0.5 Amp, Run 7.5 Amp, Start/0.8 Amp, Run
Type III	Blower Disk Drive	208/220 208/220	±10% ±10%	Single Single	50 ± 1/2 50 ± 1/2	2 Amp, Start/0.5 Amp, Run 7.5 Amp, Start/0.8 Amp, Run

NOTE: A switch located on the rear of the machine is attached to two terminals and is used to control the disk drive motor by opening and closing a 48-vdc interlock line. The blower should be on whenever dc power is applied to the machine.

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Figure 4-2. Primary AC Power Inputs

Use	Voltage (dc)	Tolerance	Current
Signal Lines	-3V	± 4%	0.3 Amp
Signal Lines	+3V	± 4%	0.3 Amp
Control Circuits	+6V	± 4%	0.4 Amp
Control and Interlock Circuits	+48V	± 8%	3.0 Amp
NOTE: To prevent damage to internal circuits of the machine, the +3 vdc, -3 vdc, and +6 vdc power must be applied to and removed from the machine at the same time. The +48 vdc power must never be applied without all other dc voltages being present.			

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Figure 4-3. Primary DC Power Inputs

4.2 POWER SEQUENCING

4.2.1 Power On Sequence

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

4.2.2 Power Off Sequence

AC power to spindle drive motor is removed before dc power to machine is removed.

5.1 MACHINE CHARACTERISTICS

5.1.1 General Characteristics

Dimensions (Figure 5-1)	Height 11.50" Width 16.37" Depth 22.41"
Weight	65 lbs.
Primary Power Requirement . . .	115 or 208/230 vac, single phase
DC Input Supply Voltages from System Control Unit	+48v, +6v, +3v, -3v
Operating Environment	50 to 110°F, 8% to 80% RH (85°F Max, Wet Bulb)
Cooling	Forced Room Air, Ambient at Installed Location
Air Circulation	50 to 70 CFM (Ducted)
Mounting	Cast Aluminum Base Plate Casters and Standoffs (Enclosure)
Connecting Cables	One Signal, One AC, DC power
Disk Rotational Speed	1500 RPM counterclockwise
Sector Capacity	321 twenty-bit words (Fixed Length Record)
Time for Trailing Edge of Sector Pulse to Sync Field	250µs ±15% (Fixed Length Record)
Length of Sync Field	One 20-bit word (Fixed Length Record)
Total Capacity of Disk (200 Tracks)	513,600 twenty-bit words (Fixed Length Record)

5.1.2 Functional Characteristics

Capacity:

Track	27,100 Bits Max.
Cylinder	54,200 Bits Max.
Disk	11 million Bits Max.

Recording Technology:

Track Density	100 TPI
Bit Density	1025 BPI Inside Track
Medium	Interchangeable Single Disk
Recording Band	2.030 Inches
Disk Diameter	14 Inches
Coding	Double Frequency
Bit Frequency	720 KC

Access Mechanism

Actuator	Electromagnet Voice Coil
Detent	Electromechanical
Access Motion Time	
Single Step	15 MS
Average Random* . .	500 MS
Maximum*	1500 MS
Head Settling Time**	20 MS Max.

Rotational Characteristics

Rotational Period	40 MS

Notes:

* Access times shown assume the use of two-step moves whenever possible. If only single-step moves are used, the average random access time will be 1000 ms and the maximum will be 3000 ms.

** Head settling time is provided by the system following the last access motion to allow mechanical vibrations in the head to settle out before reading or writing information.

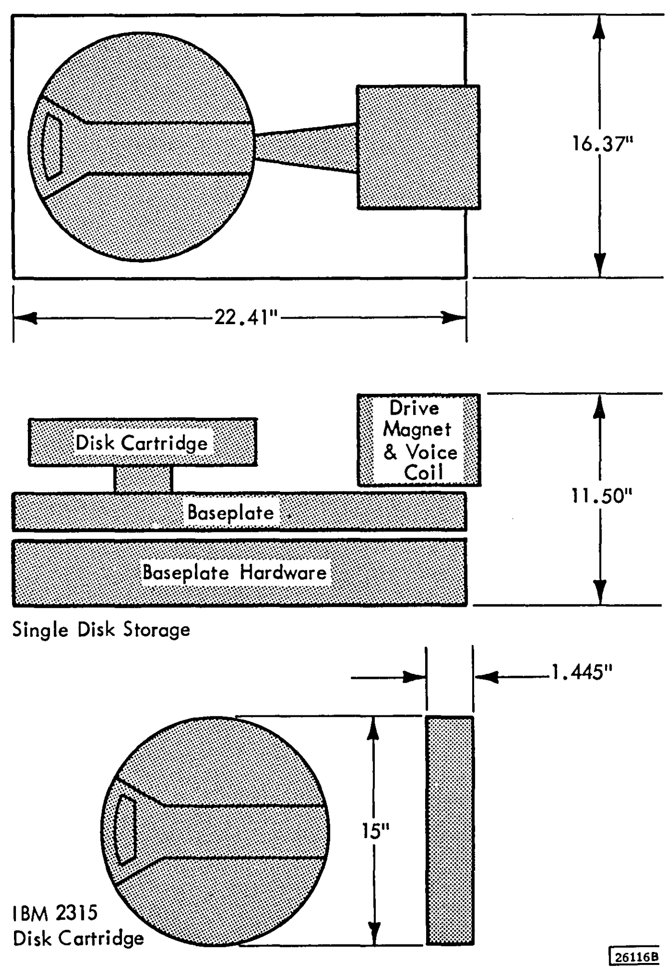

Figure 5-1. Single Disk Storage and IBM 2315 Cartridge External Measurements

5.1.3 Attachment Characteristics

The single disk storage is designed to minimize the complexity of attachment to a host system. A single 20-signal cable provides all the signal lines necessary for communication. The data format is left to the using system where a proper evaluation for the complexity of formatting versus storage efficiency may be made.

5.1.3.1 Size and Mounting

The overall dimensions of the machine are shown in Figure 5-1. The air intake is located in the rear of the machine and covers designed for cabinet enclosures provide for this feature. The SLT gate hinges out the rear of the machine and space has been allowed to prevent interference. The base plate is horizontally mounted and the mounting height of the unit provides for ease of insertion and removal of the cartridge.

5.2 VENTILATION AND ENVIRONMENT

5.2.1 Ventilation Air Supply

Although the single disk storage is designed to be rugged and reliable, it is a precision mechanism whose performance can be seriously hampered by mproper installation. Dust and other airborne contaminants are a major threat to the operating ife of the recording components and actuator.

The machine produces its own air supply of 50 to 0 CFM to cool the electronic gate and pressurize the artridge with doubly filtered air to prevent migration f particles to the head-disk area. Two filters in the ir flow provide for purification of air circulated to the artridge, and are quite effective if excessive contamination is not present in air reaching the inlet duct.

Every effort should be made, both within the host ystem and machine installation to minimize exposure f the single disk storage to airborne contaminants. The machine should be mounted away from dust genrating machines and fixtures in the host system such as card and paper-tape punches, paper and card feeds, metal hinges, etc. Special care must be taken to protect the machine within the system covers. Cleanliness procedures such as those used in magnetic tape and other storage medium installations must be observed.

5.2.2 Compatibility of Cartridges

To ensure interchangeability of cartridges among several machines, the disk within the cartridge must be at nearly the same temperature as the machine base plate when reading or writing of data. Interchangeability conditions must be complied with as follows:

1. Storage location must assure that the stored cartridge is within 5° F of the *ambient cooling air drawn into the machine.
2. Cartridges which are stored outside of this temperature range must be acclimatized within the 5°F range for two hours prior to insertion into the machine.
3. A cartridge that is within the specified operating range may be inserted into an energized machine, provided no writing is done for 15 minutes, and providing read errors are acceptable until the cartridge becomes acclimatized. (Approximately 1 to 15 minutes is required for the cartridge to become acclimatized.)

The non-operating temperature and humidity requirements for storing the cartridge are the same as those for the machine.

The cartridge has been designed to be rugged and to withstand reasonable handling. Negligent exposure to dropping, excessive temperatures, and the stacking of heavy objects on the cartridge could cause damage. Damaged cartridges should not be inserted into the machine since resultant damage to the machine may occur.

*Ambient cooling air is defined to be room air of the system installation at the place where it is drawn in through the system covers for cooling the disk drive device.

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