300-MEGABYTE MOVING HEAD DISK DRIVES

GENERAL DESCRIPTION

3B20D MODEL 2 PROCESSOR

1. GENERAL

1.01 This section provides a brief physical and functional description of the 300-megabyte moving head disk drives used by the 3B20D Model 2 processor. The 3B20D Model 2 processor will be referred to as 3B20D2 in this document.

1.02 When this section is reissued, the reason(s) for reissue will be listed in this paragraph.

PURPOSE

1.03 The disk drives are high-speed, random access memory devices used for mass data storage in a 3B20D2 System.

CONFIGURATION

1.04 The disk drives are connected to the 3B20D2 via a disk file controller, duplex dual serial bus selector, and a dual serial channel. The disk file controller can communicate with as many as 16 disk drives.

1.05 The disk drives that can be used with the 3B20D2 processor are as follows:

- KS-22072, L1

● KS-22072, L2

● KS-22707, L1 (with dual channel option).

2. PHYSICAL DESCRIPTION

2.01 A disk drive can be located in a moving head disk frame (J1C131B-1) with an associated 2000VA disk file inverter (ED-4C172-30) and power control unit (J1C131AA-1). The frame is 7 feet high and 2 feet 2 inches wide (Fig. 1). A disk drive can also be located separately with an associated 6-foot-high disk power cabinet (J1C175A-1). The disk power cabinet contains a maximum of three 2000VA disk file inverters and three power control units (Fig. 2).

2.02 The disk drives are installed in enclosures that are acoustically insulated to reduce noise levels. These enclosures measure 23 inches wide by 36.5 inches deep by 40.25 inches high. The complete moving head disk drive unit weighs approximately 500 pounds. Figure 3 illustrates the KS-22072/KS-22707, L1, disk drive. Figure 4 illustrates the KS-22070, L2, disk drive.

2.03 The disk drives are enclosed by a *quiet enclosure* that is constructed of tubular steel with removable top, front, and side panels. Each panel contains layers of sound-deadening, foam-type materials that are flame-retardant and that provide sound isolation to noises generated within the moving head disk drives. Operating controls and indicators are mounted on the enclosure front panel and are readily accessible to the user. The hinged top cover protects the internal drive assemblies and prevents dust and other contaminants from entering the drive.

2.04 Figure 5 shows the KS-22072/KS-22707, L1, and KS-22072, L2, operator control panels. Table A lists the L1 operator controls and their functions, and Table B lists the L2 operator controls and their functions.

2.05 Each of the three disk drives has a 300-megabyte storage capacity. There are 12 disks in each disk pack (Fig. 6). The top and bottom disks are used for protection only. The remaining ten disks provide 19 data-recording surfaces and one prerecorded servo surface.
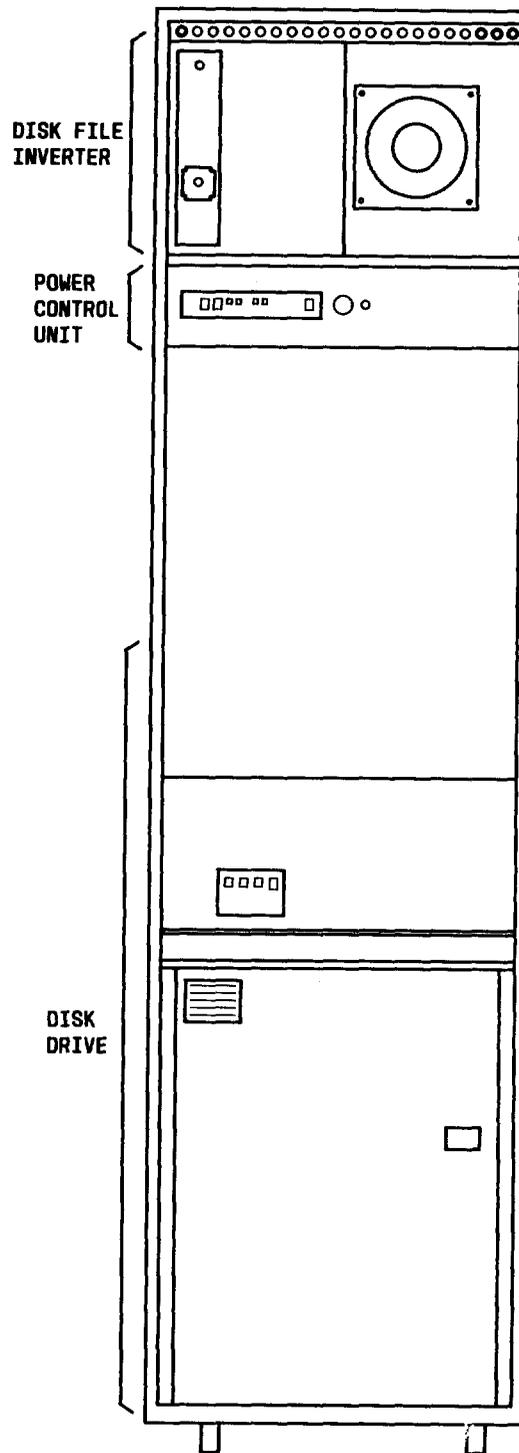

DISK FILE
INVERTER

POWER
CONTROL
UNIT

DISK
DRIVE

Fig. 1—Moving Head Disk Frame

DISK POWER
CABINET

FUSES

DISK FILE
INVERTER
0

POWER CONTROL UNIT 0

DISK FILE
INVERTER
2

POWER CONTROL UNIT 2

DISK FILE
INVERTER
1

POWER CONTROL UNIT 1

6'-0"

2'2"

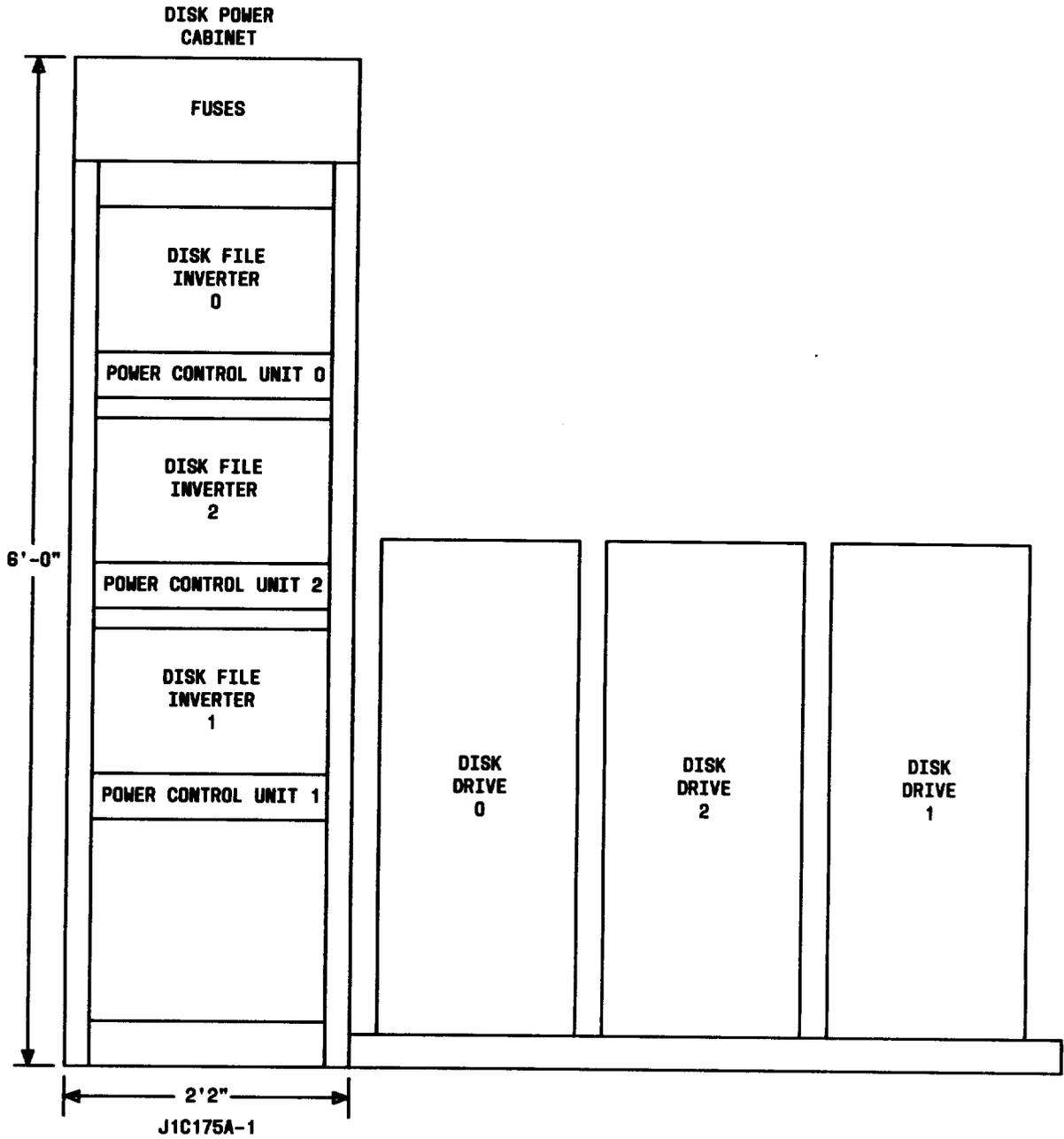J1C175A-1

DISK
DRIVE
0

DISK
DRIVE
2

DISK
DRIVE
1

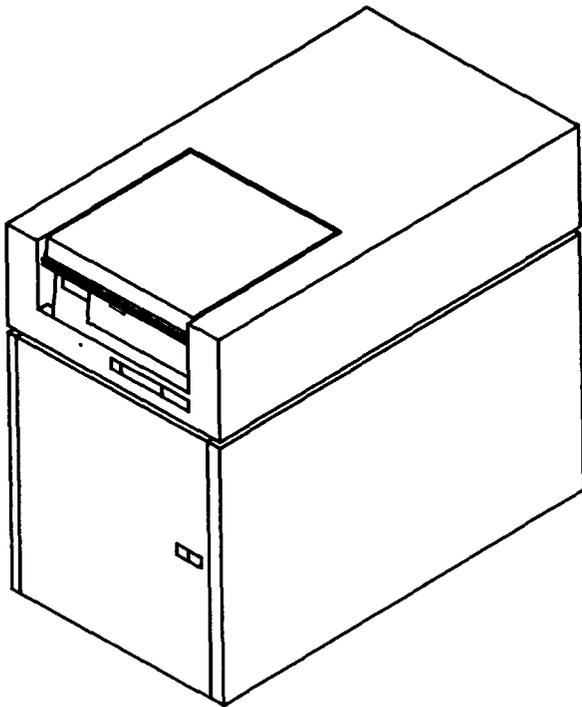**Fig. 2—Disk Power Cabinet and Disk Drives**

Fig. 3—KS-22072/KS-22707, L1, Disk Drive

2.06 Data is recorded on the disks in tracks, each of which is defined by its distance from the center of the disk. There are 384 tracks per inch (nominal spacing of 0.0026 inch). Each recording surface contains 815 tracks.

2.07 The three disk drives consist of several major assemblies. The assemblies that do not apply to all disk drives will be noted. A brief description follows:

- *Pack On Switch:* An interlock that prevents the drive motor from starting when the pack is not installed (KS-22072/KS-22707, L1).

- *Blower Assembly:* This assembly contains a blower motor that circulates cooling air for the drive.

- *Pack Access Cover Solenoid:* A device that prevents the pack access cover from being opened if the disk is spinning (KS-22072/KS-22707, L1).

- *Parking Brake:* A device that holds the spindle while the disk pack is being installed and removed.

- *Operator Control Panel Cover:* This cover contains switches that allow the operator to control and monitor the basic operation of the disk drive.

- *Shroud and Shroud Cover:* These provide protection and ventilation for the disk pack. The shroud area is protected by a shroud door which must be opened whenever the pack is loaded or unloaded. An interlock switch senses the cover being opened and prevents the disk drive from starting or causes the disk drive to perform a power-down sequence if it is running (KS-22072/KS-22707, L1).

- *Spindle and Lockshaft:* These provide a mounting surface for the disk pack. The lockshaft secures the disk pack to the spindle. The drive motor transmits rotational motion to the spindle via a drive belt causing the disk to spin. The spindle spins when a pack is installed, the pack access cover is closed, no unsafe condition exists, and the START switch is on.

- *Heads:* The heads read from or write on the disks depending on the mode selected.

- *Actuator:* This assembly positions the heads over the disks. The actuator assembly consists of a linear dc motor, carriageway, carriage, and a tachometer to provide velocity feedback. The servo head moves with the positioner and returns a position feedback signal to the servo to maintain position control (KS-22072/KS-22707, L1).

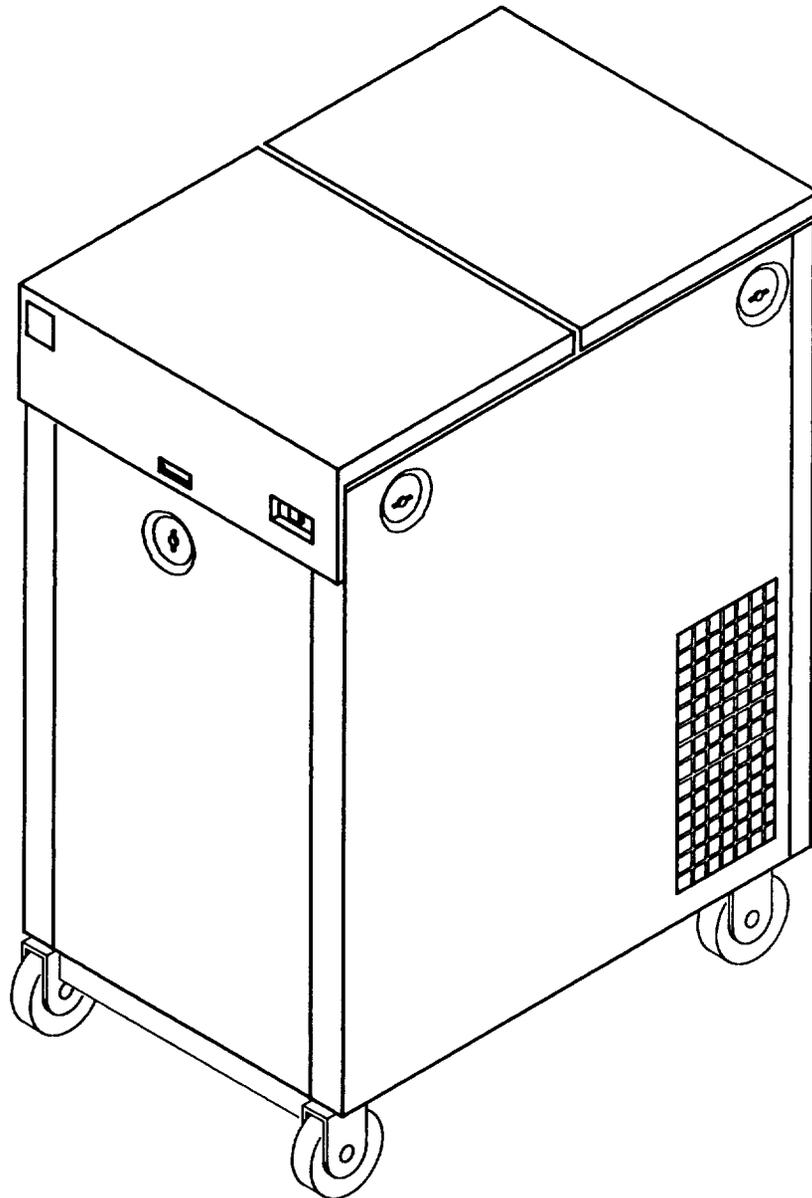- *Magnet:* This is used in conjunction with the actuator to move the carriage and heads.

Fig. 4—KS-22072, L2, Disk Drive

- *Read/Write Chassis:* The apparatus housing that contains the cards essential to the drive operation (KS-22072/KS-22707, L1).

- *Pack Access Cover Switch:* An interlock that de-energizes the drive motor if the pack access cover is opened while the pack is spinning. It also prevents the motor from starting unless the cover is closed (KS-22072/KS-22707, L1).

- *Drive Motor:* The motor that provides rotational motion to turn the spindle and disks.

- *Power Supply:* The source of all necessary voltages for the drive operations. The dc power fuse/rectifier printed circuit board contains a temperature sensor that activates the high temperature fault signal, which is sent to the controller.

- *Pack Area Lid:* Covers disk pack and seals pack area for positive air pressure. The lid is raised for unloading and loading of pack (KS-22072, L2).
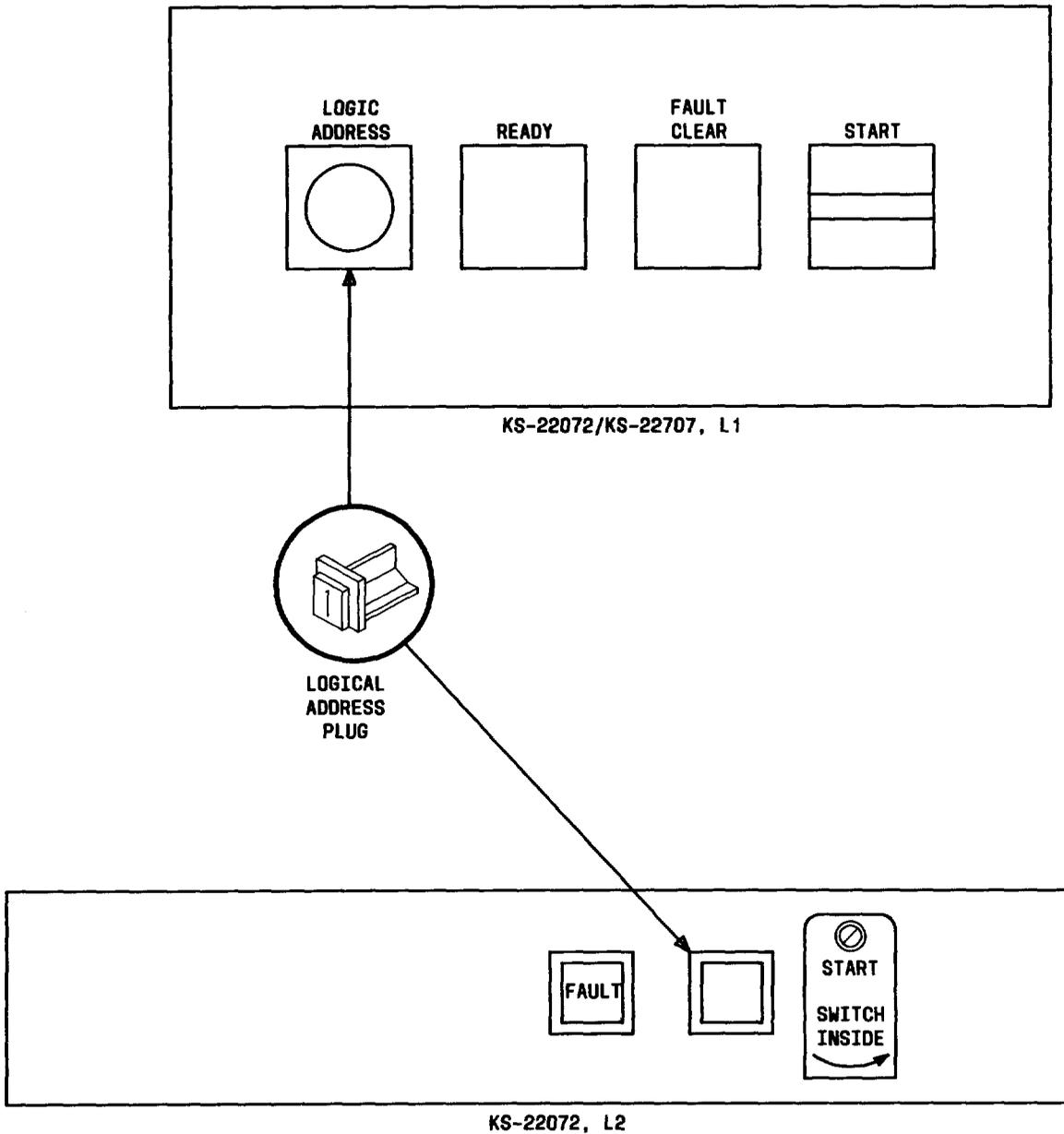
KS-22072/KS-22707, L1

LOGICAL
ADDRESS
PLUG

KS-22072, L2

Fig. 5—Operator Control Panels

- **Air Shrouds:** Front air shroud surrounds the disk pack to contain and direct air flow to the pack from the blower assembly. Also mounts pack area lid. Rear air shroud covers carriage and way assembly to contain pressurized air (KS-22072, L2).

- **Head Carriage and Way Assembly:** Mounts one servo head and 19 read/write data heads in precise alignment with the disk pack. The carriage moves the heads in and out of the disk pack under control of the head-positioning linear motor (KS-22072, L2).

- **Swing Frame:** Allows access through the rear to the interior of the machine. Also mounts the logic card cage and the equipment cooling fans (KS-22072, L2).

- **Logic Card Cage:** Contains disk drive control logic, read/write logic, and servo circuits mounted on eight plug-in circuit boards (KS-22072, L2).

TABLE A

KS-22072/KS-22707, L1, OPERATOR CONTROL PANEL FUNCTIONS

CONTROL/INDICATOR	FUNCTION
READY indicator	The indicator is lighted when the unit is: (1) Up to speed (2) Heads are positioned (3) No-fault condition exists. The indicator, when lighted, signifies that this unit is ready for disk file controller read/write.
LOGIC ADDRESS slot	The logical address plug is placed in this slot. It determines the logical address of the disk drive. The disk address can be set to any number from 0 through 15 by installing the proper plug. If no plug is inserted, the address is 15. Each plug is labeled with the address plug by the manufacturer. The disk file controller identifies a disk drive by the logical address plug inserted.
START switch/ indicator	Pressing the switch/indicator when the disk drive is in the power-off condition (disk not spinning) lights the indicator and starts a power-on sequence provided the following conditions are met: (1) Disk pack is installed. (2) Pack access cover is closed. (3) All power supply circuit breakers are on. Pressing the switch/indicator when the disk drive is in the power-on condition extinguishes the indicator and starts a power-off sequence.
FAULT switch/ indicator	The indicator is lighted if a fault condition exists within the drive. When the fault is no longer present, the indicator is extinguished by any of the following: (1) Pressing the FAULT switch on the panel (2) Fault-clear signal from the controller (3) Maintenance fault-clear switch on fault pack (in disk drive unit).

• **Read/Write Matrix Boards:** Contains the logic that is directly associated with enabling a selected head and determining the correct write current and the circuits involved in actually writing data onto or reading data from the disk pack (KS-22072, L2).

• **Power Amplifier:** Provides drive current to the linear motor bobbin to cause the head carriage motion. Provides +50V and −50V supply for spindle brake (KS-22072, L2).

• **AC Distribution Box:** Contains the distribution network that feeds ac power to the cooling fans, blower motor, elapsed time meter, and dc power supply. Also mounts the main circuit breaker and contains the relay that controls the spindle drive motor (KS-22072, L2).

• **Front, Rear, Top, and Side Covers:** Dress covers that are removable for maintenance (KS-22072, L2).

TABLE B

KS-22072, L2, OPERATOR CONTROL PANEL FUNCTIONS

CONTROL/INDICATOR	FUNCTION
FAULT switch/ indicator	Indicates that an unsafe operating condition has been detected and that corrective action is required. Pressing the pushbutton will clear any fault condition that no longer exists.
READY indicator/ logical address plug	Indicates that the drive is powered up and the heads are loaded. Logical address of the disk drive is stamped on the indicator lens. Flashes during power up until the disk drive is ready and during power down until the disk pack has stopped.
START-STOP switch	START position turns on the spindle drive motor and loads the heads when a pack is present and an unsafe condition does not exist. STOP position retracts the heads, turns off spindle drive motor, and activates the eddy current brake to stop the disks.

3. FUNCTIONAL DESCRIPTION

3.01 The KS-22072, L1 and L2, and K2-22707, L1, disk drives function in the same manner. The disk drives position read/write heads over a selected cylinder and then read or write data on a selected track. Driving the head in or out to the desired cylinder is termed a "seek."

3.02 Data is stored on a disk in a modified frequency modulation format. The nominal recording frequency is 9.67 MHz; therefore, at a normal disk speed of 3600 rpm, a data cell period is 103.3 nanoseconds. There are 20,160 bytes per track, which can be subdivided further into sectors. Switches are provided to select 32 sectors per track. Figure 7 shows the different types of switches. Switches 0, 1, 5, 7, and 8 in the closed or ON position represents 32 sectors per track.

3.03 Disk drives interface with the disk file controller by means of a control cable and a read/write cable (Fig. 8). The control cable connects to all disk drives in a daisy-chain manner, while individual read/write cables connect the disk file controller to each disk drive. Refer to Fig. 9.

3.04 The control cable carries 33 control and address signals to and from the disk drive. Table C lists these signals. The last disk drive in a string must have a terminator installed on the "control cable out" connector in place of a continuing control cable. The read/write cable contains seven signals, which are listed in Table D.

3.05 A logical address plug must be installed in the front panel of each disk drive in order for the drive to identify itself. There are 16 different logical address plugs available so that up to 16 disk drives may be uniquely identified and addressed.

3.06 Signals between the disk drives and the disk file controller are carried over twisted pair leads driven by differential line drivers. Figure 10 is a simplified diagram of the connections between control and data drivers and receivers.

3.07 The disk drives are addressed by unit select lines 0 through 3 in the control cable (Fig. 8). A match between the address on unit select lines 0 through 3 and the pattern in the logical address plug in a disk drive causes that disk drive to be selected. The unit select tag signal then enables the line receivers in the selected disk drive.

3.08 Bus bits 0 through 9 combine with cylinder select tag, head select tag, and control select tag signals to provide commands and status signals to the disk drive.

3.09 The read/write heads are moved to a cylinder position specified by the cylinder address in bus bits 0 through 9 when the cylinder select tag is active. This movement is done by a linear dc motor under control of the signals read from the servo surface of the disk pack. Figure 11 is a block diagram of the servo system.
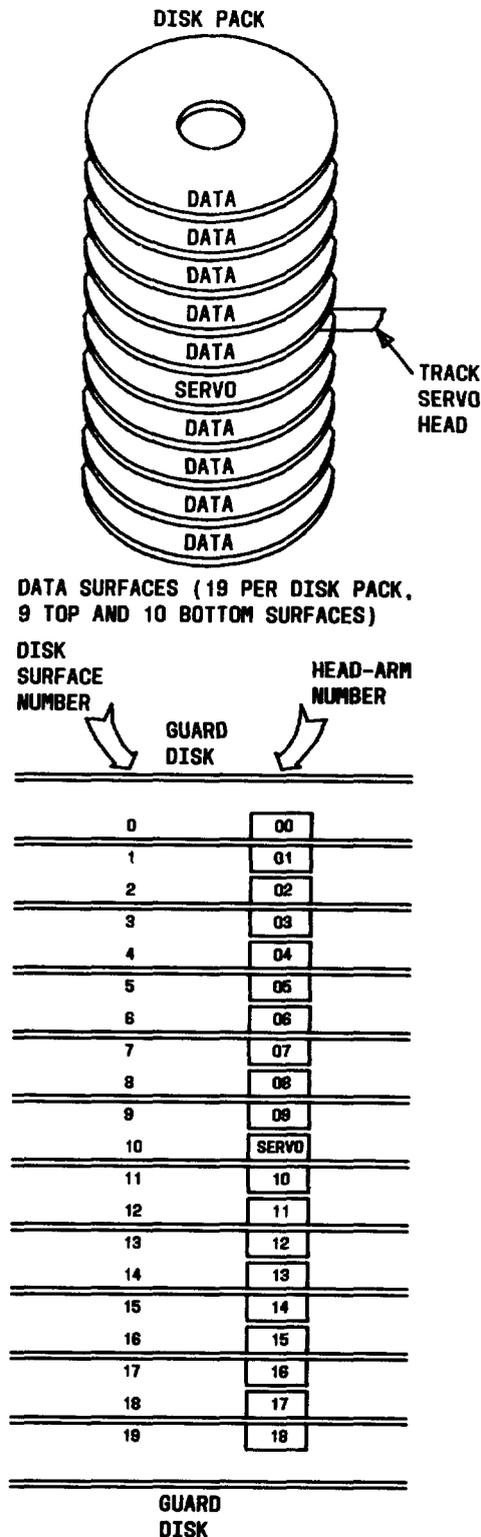
DISK PACK

DATA
DATA
DATA
DATA
DATA
SERVO
DATA
DATA
DATA
DATA

TRACK
SERVO
HEAD

DATA SURFACES (19 PER DISK PACK, 9 TOP AND 10 BOTTOM SURFACES)

DISK
SURFACE
NUMBER

HEAD-ARM
NUMBER

GUARD
DISK

DISK SURFACE NUMBER	HEAD-ARM NUMBER
0	00
1	01
2	02
3	03
4	04
5	05
6	06
7	07
8	08
9	09
10	SERVO
11	10
12	11
13	12
14	13
15	14
16	15
17	16
18	17
19	18

**GUARD
DISK**

Fig. 6—Disk Pack Layout

3.10 The disks spin at a nominal 3600 rpm. The read/write heads float on a cushion of air between the disk surface and the head. This air cushion supports the heads at approximately 0.000032 inch from the disk surface. Because of this extremely small distance, the air surrounding the disk pack must be highly filtered to remove all dust and smoke particles which otherwise would cause damage to the heads and disk. As an example of the cleanliness required, the residue from a fingerprint is twice as thick as the normal distance between the heads and disks. In order to assure the cleanliness of the air supply, an absolute air filter, which removes particles as small as 0.0000118 inch in diameter, is provided.

3.11 Data is written into each track on a disk when the proper write conditions are established. In addition, each track is divided into a number of sectors so that the location of a particular data item is defined by the track address and the sector number.

3.12 Each full turn of the disks is detected when an index mark recorded on the servo surface passes underneath the servo head. In addition, bytes are counted; and each time a sector quantity of bytes is counted, a sector mark is generated. Therefore, a particular area on a disk may be identified by cylinder number, head number (these two items define a track), and sector number.

3.13 The read/write head assembly consists of 20 read/write arms plus mechanisms to guide and support the heads. Radial positioning of the heads is done by a linear dc motor that moves the head assembly in or out to the selected track. Upon start-up, the heads remain retracted until the disk attains 3000 rpm, at which time the heads are extended over the head load zone. After a brief delay to allow the heads to fly and stabilize on the air cushion, they are positioned to the addressed track by the linear motor.

4. MAINTENANCE

4.01 Manual and routine maintenance will be performed using Task Oriented Practices to guide and direct step-by-step procedures. In those cases where these procedures are inconclusive or ineffective, the operator will be directed to higher level maintenance centers and documentation.
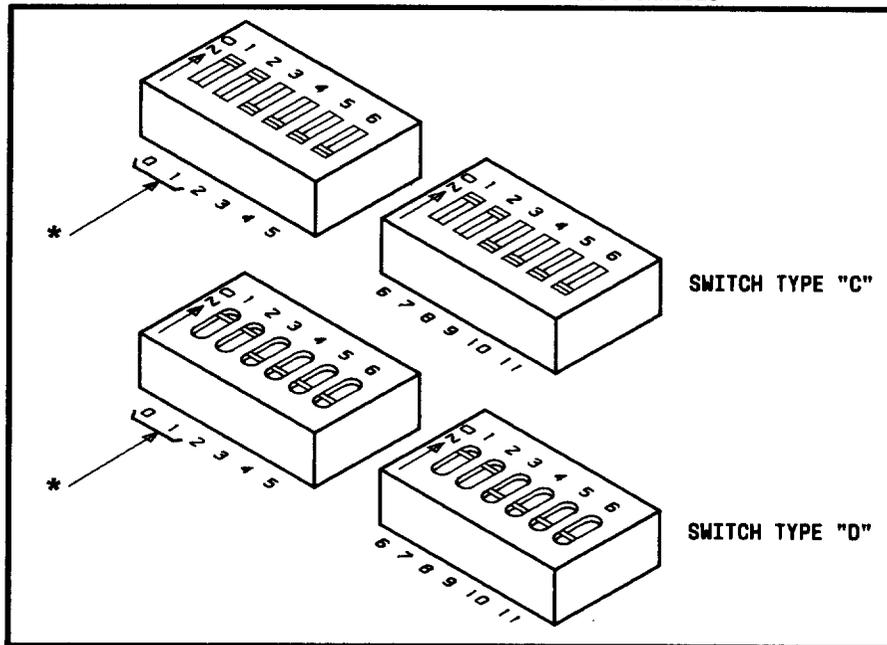
ROCKER-TYPE SWITCHES

SWITCHES LOCATED ON A CARD IN LOGIC CHASSIS

SWITCH TYPE "A"

SWITCH TYPE "B"
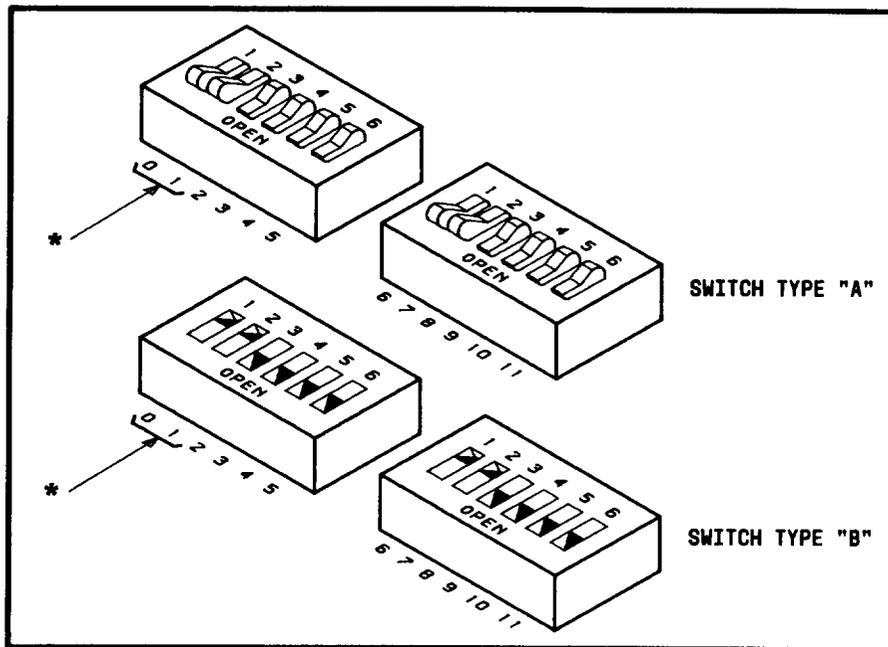
* SWITCHES 0 AND 1 SHOWN IN CLOSED POSITION.

SLIDE-TYPE SWITCHES

SWITCHES LOCATED ON A CARD IN LOGIC CHASSIS

SWITCH TYPE "C"

SWITCH TYPE "D"

* SWITCHES 0 AND 1 SHOWN IN ON POSITION.

Fig. 7—Servo Select Switches

CONTROL CABLE	A C A B L E	PICK IN →	A C A B L E	MOVING HEAD DISK DRIVE

Control Cable signals (A CABLE):

- PICK IN →
- HOLD →
- OPEN CABLE DETECT →
- UNIT SELECT TAG →
- UNIT SELECT 2^0 →
- UNIT SELECT 2^1 →
- UNIT SELECT 2^2 →
- UNIT SELECT 2^3 →
- TAG 1 (CYLINDER SELECT) →
- TAG 2 (HEAD SELECT) →
- TAG 3 (CONTROL SELECT) →
- BIT 0 →
- BIT 1 →
- BIT 2 →
- BIT 3 →
- BIT 4 →
- BIT 5 →
- BIT 6 →
- BIT 7 →
- BIT 8 →
- BIT 9 →
- ← UNIT READY
- ← ON CYLINDER
- ← SEEK ERROR
- ← INDEX
- ← SECTOR
- ← ADDRESS MARK FOUND
- ← WRITE PROTECT
- ← FAULT
- ← PICK OUT
- ← HIGH TEMP FAULT
- ← HEADS UNLOADED

DISK FILE CONTROLLER

Read/Write Cable signals (B CABLE):

- WRITE DATA →
- WRITE CLOCK →
- ← SERVO CLOCK
- ← READ DATA
- ← READ CLOCK
- ← SEEK END
- ← UNIT SELECTED

READ/WRITE CABLE

Fig. 8—Control and Read/Write Cables
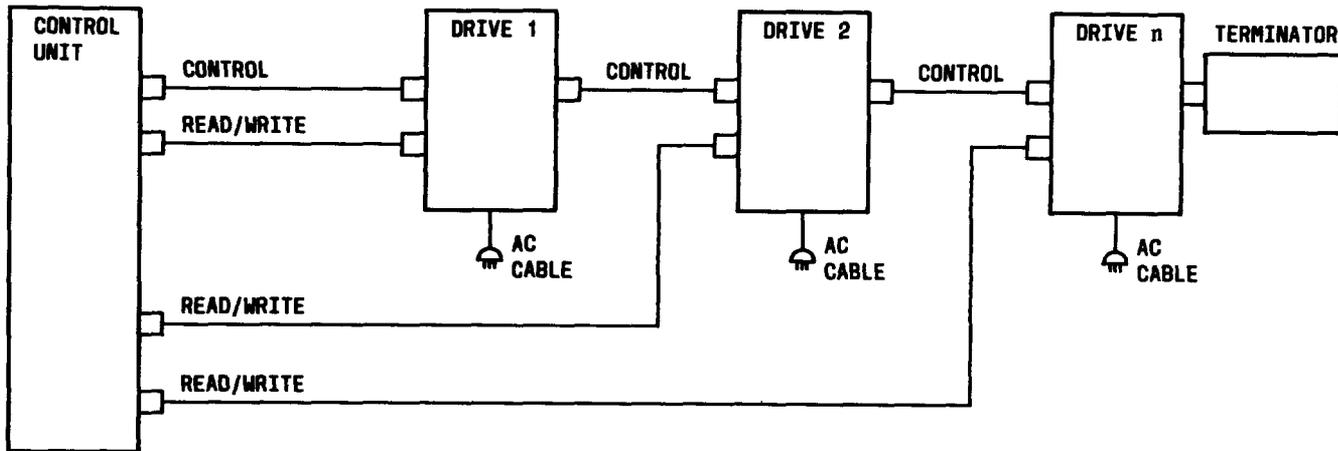
Fig. 9—System Daisy-Chain Configuration

5. POWER

5.01 The disk drive requires 208V 60-Hz single-phase power, which is supplied by a disk file inverter. The disk file inverter receives −48 Vdc power via a dedicated 50-ampere fuse in the power distribution frame. Due to the high current involved, −48V power is connected directly to the input terminals of the disk file inverter for protection.

5.02 The disk file inverter contains a microprocessor that controls the output frequency and voltage level. The microprocessor causes −48V power to be interrupted and passed through a transformer as high-voltage pulses. The pulses feed a transformer with a multiple tap secondary. The microprocessor selectively triggers silicon-controlled rectifiers connected in series with the transformer secondary in a predetermined sequence, which approximates a sine wave. This sine wave is the output of the inverter.

5.03 The disk file inverter also contains two cooling fans, a fuse, and two plug-in circuit packs. One circuit pack contains the microprocessor and control circuitry while the other contains the silicon-controlled rectifiers. An interlock switch is provided to remove −48V power from the circuit pack area when access to the circuit pack is required. The circuit pack main cooling fans are connectorized and replaceable.

5.04 The power control unit contains circuitry for controlling the application of ac voltage to the disk drive. The control unit also contains a plug-in control unit (ED-4C194) that controls the inverter. In addition, a front-mounted fuse provides −48V power to the ED-4C194 control unit. Should the fuse fail, ac power is removed from the disk drive with the resultant loss of service of that unit.

5.05 On the rear of the power control unit, ac power is provided to the disk drive through connector J4. Connector J4 contains the power, neutral, motor start, and run leads, as well as control signals. The start and run leads are required because of the type of motor used in the disk drive.

6. REFERENCES

6.01 The following manufacturer publications provide operation and maintenance instructions for the KS-22072, L1 and L2, and KS-22707, L1, disk drives:

(1) Control Data Corporation Installation, Operation, and Maintenance Manual, KS-22072, L1, and KS-22707, L1, Disk Drives

(2) Century Data Systems Installation, Operation, and Maintenance Manual, Model 833, KS-22072, L2, Disk Drive.

TABLE C

CONTROL CABLE FUNCTIONS

SIGNAL/LINE	FUNCTION
Pick in*	Used for power sequencing. A ground on this line causes the disk drive to power up if the LOCAL/REMOTE switch is in REMOTE and the START switch is on. When the disk drive is up to speed, a pick out line is connected to the pick in line for the next disk drive. If the LOCAL/REMOTE switch is in LOCAL, the pick in line is always grounded; therefore, the pick out signal is always connected to the next drive.
Hold	Used for power sequencing. This line must be grounded at the controller for the disk drive to complete and hold the power-up sequence.
Open cable detect	Inhibits unit selection and any unwanted command such as write gate when the "A" cable is disconnected or controller power is lost.
Unit select tag	Used in conjunction with unit select lines 2^0 through 2^3 to initiate the unit select sequence.
Unit select lines 2^0 through 2^3	Used to select the drive. The binary code on these lines must match the code of the logical address plug for the drive to be selected. These lines are used in conjunction with the unit select tag.
Tag 1 (cylinder select)	Used to load bus bits 0 through 9 into the disk drive where they are interpreted as a new cylinder address. Bus bits are interpreted as follows: **BUS BIT** **FUNCTION** 0 Cylinder address 2^0 1 Cylinder address 2^1 2 Cylinder address 2^2 3 Cylinder address 2^3 4 Cylinder address 2^4 5 Cylinder address 2^5 6 Cylinder address 2^6 7 Cylinder address 2^7 8 Cylinder address 2^8 9 Cylinder address 2^9

* This line is called pick in when input to the disk drive but is called pick out when output from the disk drive.

TABLE C (Contd)

CONTROL CABLE FUNCTIONS

| SIGNAL/LINE	FUNCTION
Tag 2 (head select)	Initiates head select function and is used in conjunction with signal on bus bit lines. This tag strobes the head address, contained on bus bit lines, into drive logic. Bus bits are interpreted as follows: **BIT BIT** **FUNCTION** 0 Head address 2^0 1 Head address 2^1 2 Head address 2^2 3 Head address 2^3 4 Head address 2^4 5—9 Not used
Tag 3 (control select)	Intiates various operations to be performed by the drive. Used in conjunction with bus bit lines. Specific operation initiated depends on content of these lines as follows: **BUS BIT** **FUNCTION** 0 Write select. Enables write drivers. 1 Read select. Enables the digital read data lines. With phase locked oscillator option, leading edge triggers read chain to sync on all-zeros pattern. 2 Servo offset plus. Offsets the actuator from the nominal or cylinder position toward the spindle. 3 Servo offset minus. Offsets the actuator from the nominal or cylinder position away from the spindle. 4 Fault clear. Pulse sent to drive to clear the fault summary flip-flop. This is also used for head loading. 5 Address mark enable. When combined with a write select, the selected track is erased. When combined with a read select, an address mark search is initiated. 6 Return to zero. Pulse sent to disk drive to cause actuator to seek to track zero. Also, when combined with a read select, a head retract is initiated. 7 Data strobe early. Enables the phase locked oscillator data separator to strobe the data at a time earlier than optimum.

TABLE C (Contd)

CONTROL CABLE FUNCTIONS

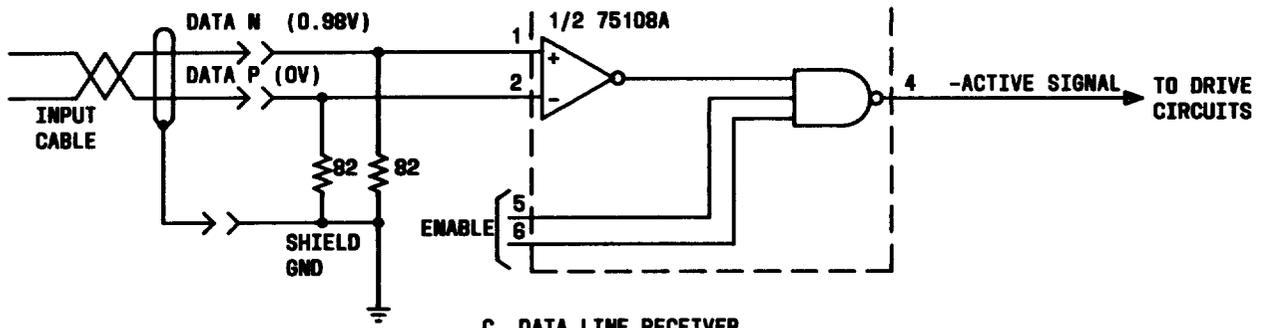| SIGNAL/LINE	FUNCTION	
	BUT BIT	**FUNCTION**
	8	Data strobe late. Enables the phase locked oscillator data separator to strobe the data at a time later than optimum.
	9	Release (dual channel units only). Activating this signal line releases channel reserve and channel priority select reserve in the disk drive, making alternate channel access possible after selection by the other channel ceases.
Bus bits (0—9)	Used in conjunction with tags 1, 2, and 3.	
Unit ready	When activated, indicates that the disk drive is selected and up to speed, that the heads are loaded, and that no fault exists.	
On cylinder	When activated, indicates that the disk drive has positioned the heads over the selected track.	
Seek error	When activated, indicates that the unit was unable to complete a seek within 500 ms or that the carriage has moved to a position outside the recording field.	
Busy	This signal is generated when a controller attempts to select or reserve a disk drive that has already been selected and/or reserved by the controller. This signal is sent to the controller attempting the selection.	
Index	Occurs once per revolution of the disk. The index signal leading edge is considered the leading edge of sector zero.	
Sector	This signal is derived from the servo surface of the disk. The number of sector pulses occurring depends on the setting of switches.	
Address mark	Indicates that an address mark has been found. Enabled by a combination of read gate and address mark enable.	
Fault	Indicates that one or more of these faults exist: dc power fault, head select fault, write fault, write or read while off cylinder, and write gate during a read operation.	
Pick out	When the drive is up to speed, this line is grounded. This signals the controller to send the pick in signal to the next disk drive in the sequence.	
High temperature fault	Indicates that the temperature is excessive in the internal air flow system.	
Heads unloaded	Indicates that the heads are not loaded (in the BJ4A2Y only).	

TABLE D

READ/WRITE CABLE FUNCTIONS

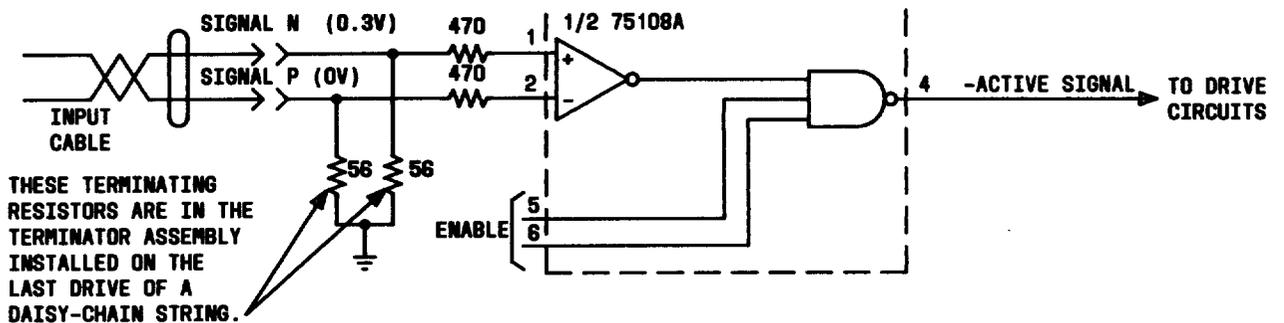| SIGNAL/LINE	FUNCTION
Servo clock	9.67 MHz clock signals derived from servo track dibits.
Read data	Carries nonreturn-to-zero data recovered from the disk pack.
Read clock	Clock signals derived from nonreturn-to-zero read data.
Seek end	Seek end is a combination of on cylinder and seek error signals indicating that a seek operation has terminated. If an address greater than 822 cylinders has been selected, there will be no change in seek end status.
Unit selected	Indicates that the disk drive is selected. This line must be active before the disk drive will respond to any commands from the controller.
Write data	Carries nonreturn-to-zero data to be recorded on the disk pack.
Write clock	The write clock is synchronized to nonreturn-to-zero write data and is a return of the servo clock. This signal is transmitting continuously.
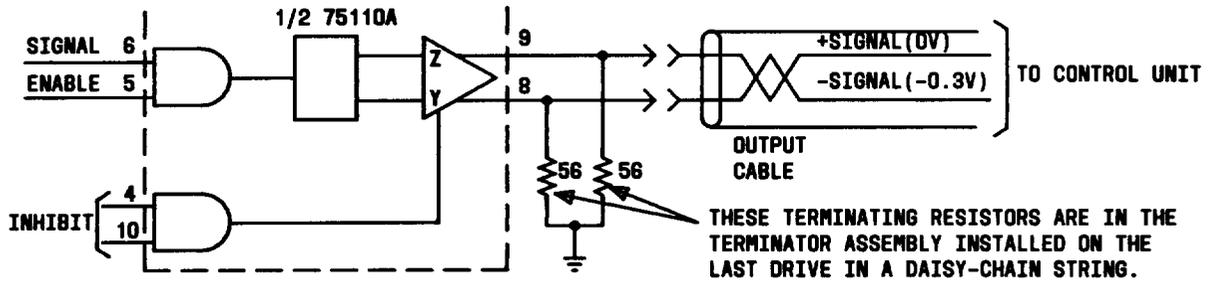
A. STATUS LINE TRANSMITTER
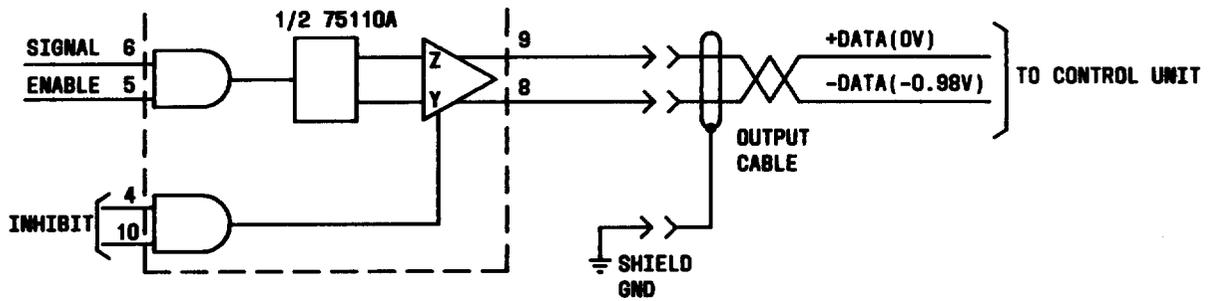
B. DATA LINE TRANSMITTER

C. DATA LINE RECEIVER

D. CONTROL LINE RECEIVER

Fig. 10—Line Drivers and Receivers

CYLINDER
ADDRESS
REGISTER
BITS

BUS OUT
BITS

SET CAR

DIFF
CALCU-
LATOR

CALCULATED
DIFFERENCE
AND
DIRECTION

DIFF
COUNTER

DIFFERENCE
TO GO

DIRECTION

DIFF-0

CURRENT
SOURCE
(MAGNITUDE)

FORWARD OR
REVERSE
DRIVING
BITS

ERROR
AMPL

POLARITY
DETECTOR

FWD
AMPL

REV
AMPL

POWER
DRIVER

LINEAR
MOTION

SERVO
HEAD

LOCK ON

FINE MODE
SERVO
CONTROL

VELOCITY FEEDBACK (TACHOMETER)

LINEAR
TACHOMETER

DECREMENT
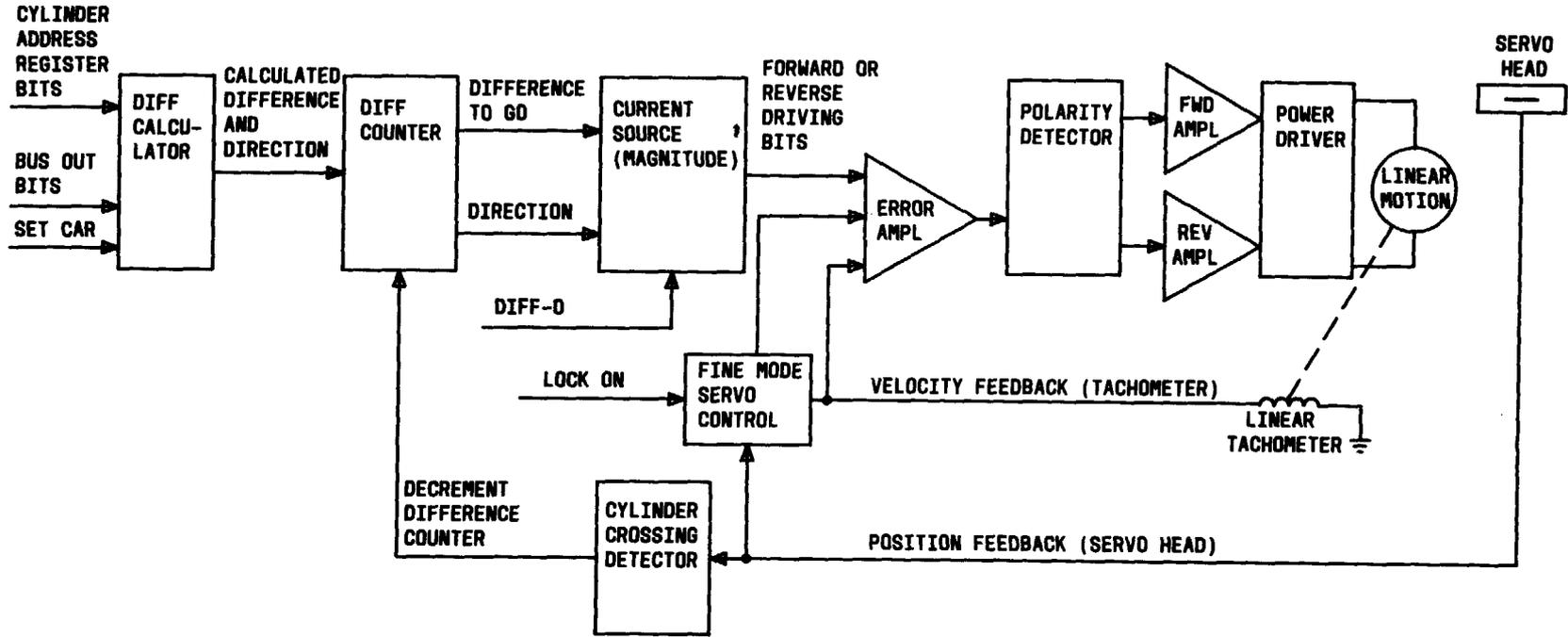DIFFERENCE
COUNTER

CYLINDER
CROSSING
DETECTOR

POSITION FEEDBACK (SERVO HEAD)

Fig. 11—Basic Servo Block Diagram