3.5Inch MSX Micro FDD System
FD-03/FD-031

TECHNICAL SUMMARY

PREFACE

The FD-03 is a 3.5-inch micro floppy disk drive system for the MSX computer system. The system connection configuration is illustrated in Figure 1-1. Throughout this manual, the names shown in Figure 1-1 are used.
This system can store 360K byte of data per drive unit and can operate on two combined drives (drive A and drive B). Drives A and B are connected with slot of the MSX computer through the interface cartridge.
Power supplied to drive A is provided by AC adapter, as shown in Figure 1-1. This power supply is adequate to supply power to the additional drive B.

CONTENTS

1 3.5-INCH FLOPPY DISK DRIVE SYSTEM (FD-030, FD-031)

Overview

Fig. 1-1

Specifications

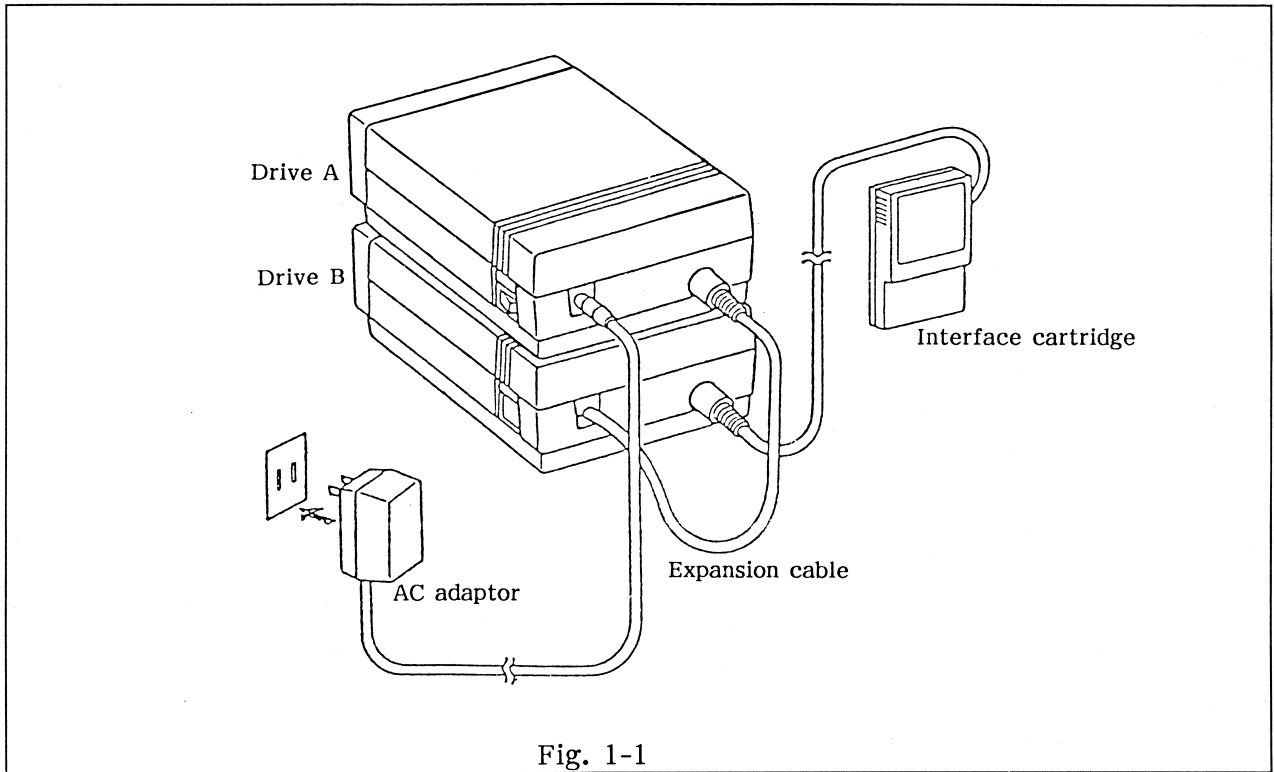Usable disk   3.5-inch single sided MF-1DD (135 TPI)
Storage capacity   Unformatted; 500K bytes
                                     Formatted; 360K bytes
                                             512 byte/sector
                                             9 sector/track
                                             1 track/cylinder
                                             80 track/disk
Recording density   8187 bit/inch
Track density   135 track/inch
Total number of cylinders   80
Total number of tracks   80
Recording method   MFM modulation
Data transfer rate   250K bit/sec
Average rotation wait time   100 msec
Access time   Average; 664 msec
                                     Between track; 24 msec

	Drive A	Drive B	Cartridge
Power supply	Ac adaptor 7.5V 1A	+5V supplied from Main unit	+5V supplied from MSX cartridge slot
Power consumption	TYP. 4.5W MAX. 6.0W	TYP. 2.5W MAX. 3.5W	About 1W

Working temperature   37°F - 67°F
Maximum outside dimension   132 mm x 207 mm x 64 mm   (W x L x H)
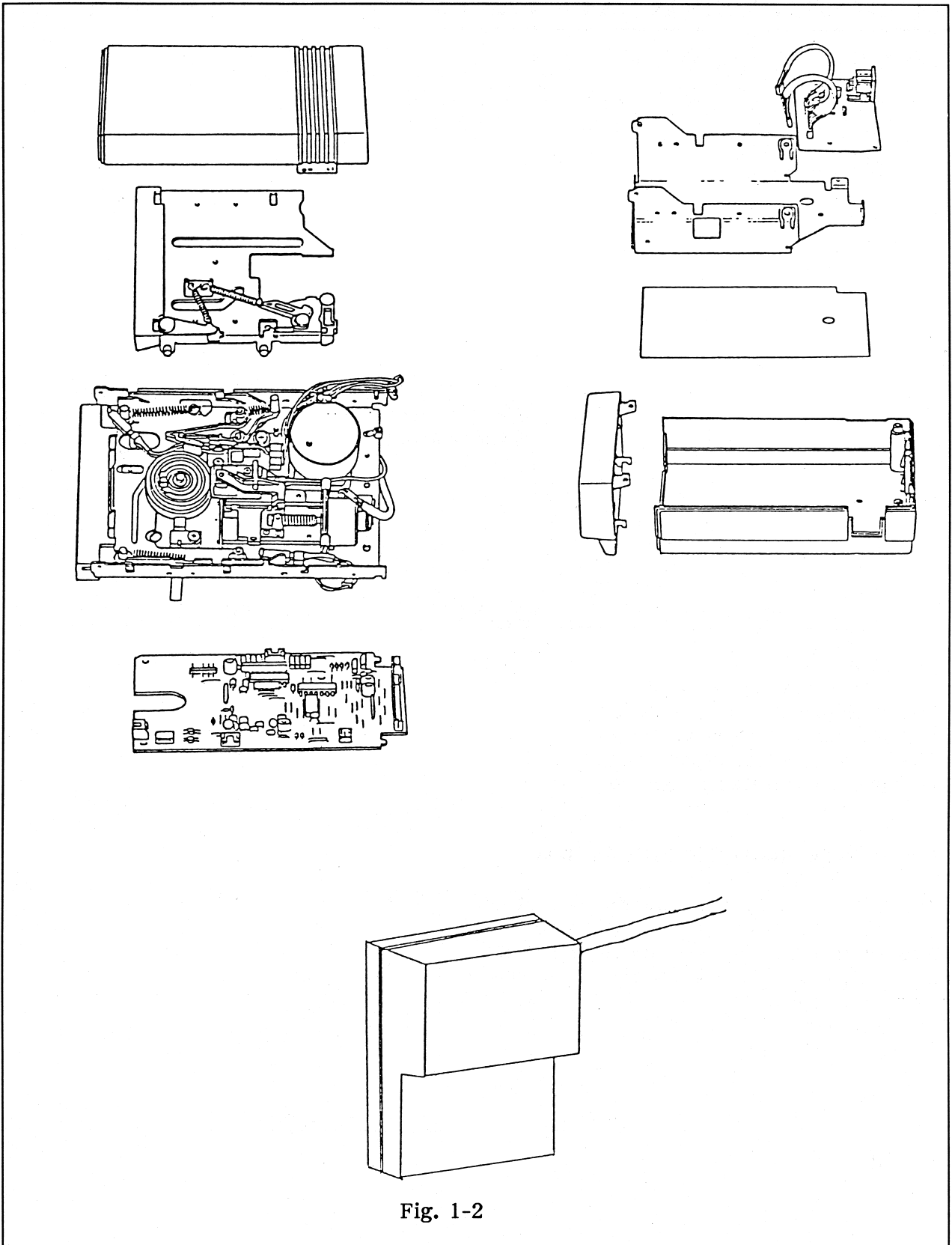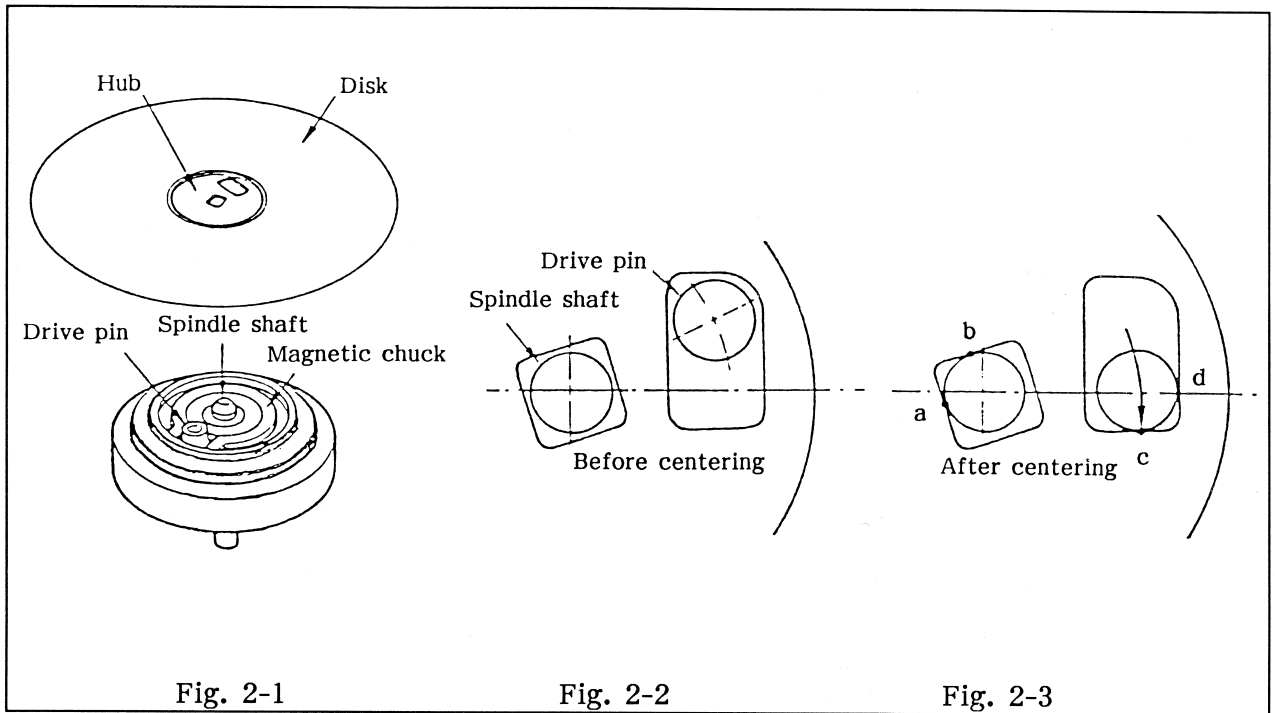Weight   1.2 kg

Block diagram

Fig. 1-2

3

2 OPERATIONAL PRINCIPLE OF MECHANICAL (DRIVE A, DRIVE B)

DISK DRIVE CONFIGURATION

Fig. 2-1   Fig. 2-2   Fig. 2-3

The hub is made of magnetic metal and has two holes as shown in Figure 2-1. The middle one receives the spindle and the other one is for the drive pin.
When a floppy disk is inserted, the hub is attracted by a magnetic force. The spindle rotates clockwise to move the drive pin as shown Figure 2-2 and Figure 2-3. Pin contacts a and b, c and d and is positioned.
The spindle is rotated at 300 rpm.

READ/WRITE HEAD CONFIGURATION

The Read/Write head is always in contact with the disk. The surface of the head is designed to minimize wear on the head and disk. This will maximize the data read signal from the disk.

Fig. 2-4
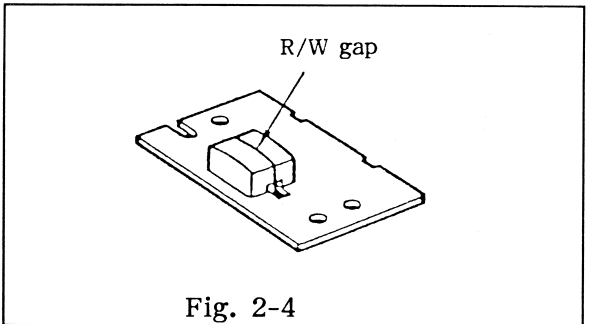
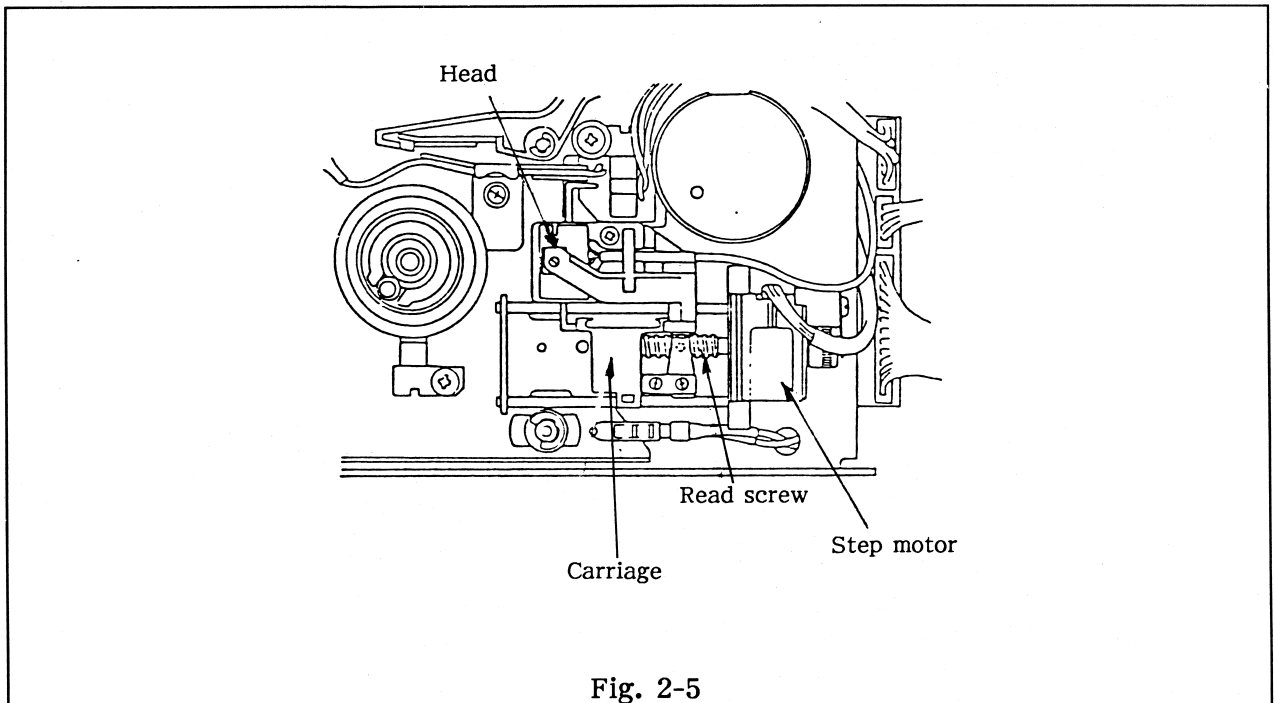## HEAD POSITIONING MECHANISM

Fig. 2-5

The head is mounted on the carriage and positioned with the step motor and lead screw. When one pulse is applied to the step motor, lead screw rotates by 15 and the head moves 0.046875 mm. Four steps of the step motor is equal to a travel for one track (0.1875 mm).

DISK PAD MECHANISM

The Read/Write head contacts the disk by means of a pad which presses on the disk as shown in Figure 2-6.
The pad is designed to maximize the data read signal by means of a pad arm spring, mounted between the pad arm and the carriage.
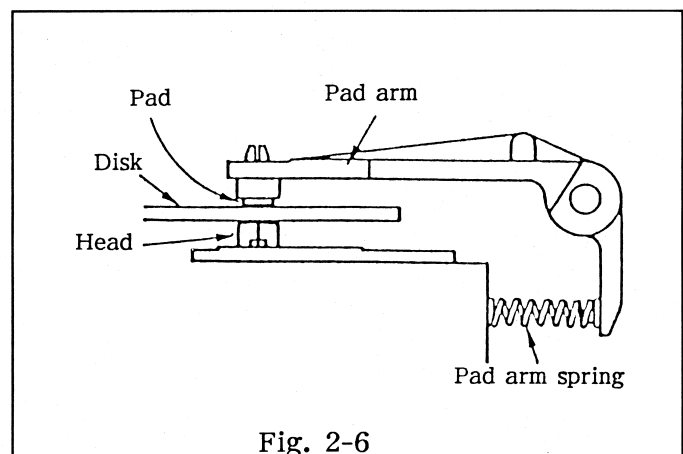

Fig. 2-6

DISK REMOVAL MECHANISM

With the disk inserted, a disk holder presses the shutter lever. The shutter lever rotates to open the shutter of disk. When a disk is inserted deep into the holder, the shutter lever is locked with the shutter stopper and it pushes the slide plate stopper at the same time.

Disk holder Slide plate stopper

Shutter lever

Shutter stopper

Disk

Shutter Lever Spring

Fig. 2-7
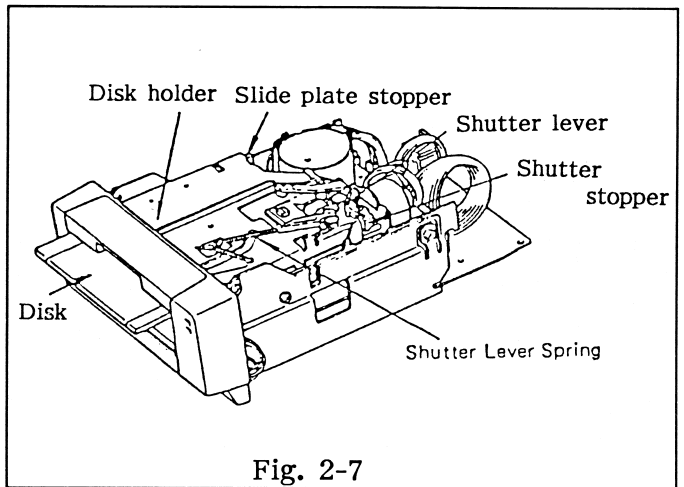
The slide plate stopper rotates to unlock the slide plate. The slide plate slides under spring tension. The disk holder snaps down and the disk is chucked in place.

Slide plate stopper

Slide plate spring Slide plate

Slide plate spring

Fig. 2-8
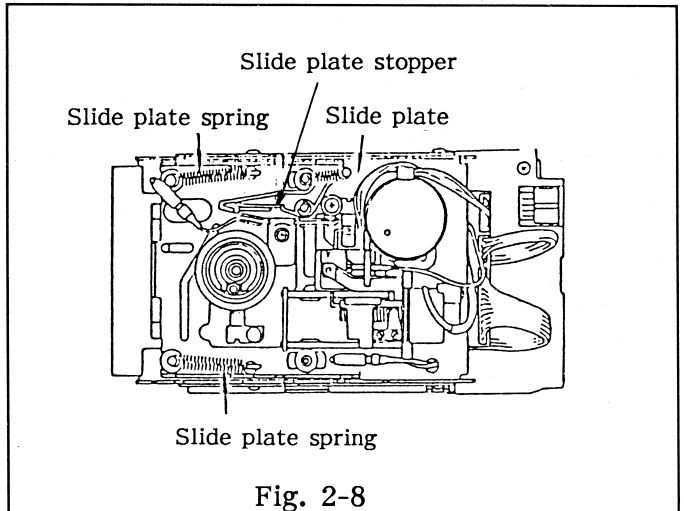
By pushing the Eject lever, the disk holder raises and the disk claw holder pushes the shutter stopper to unlock the shutter lever. The tension of the shutter lever spring, cause the disk to be ejected.

Claw of disk holder

Eject lever

Fig. 2-9
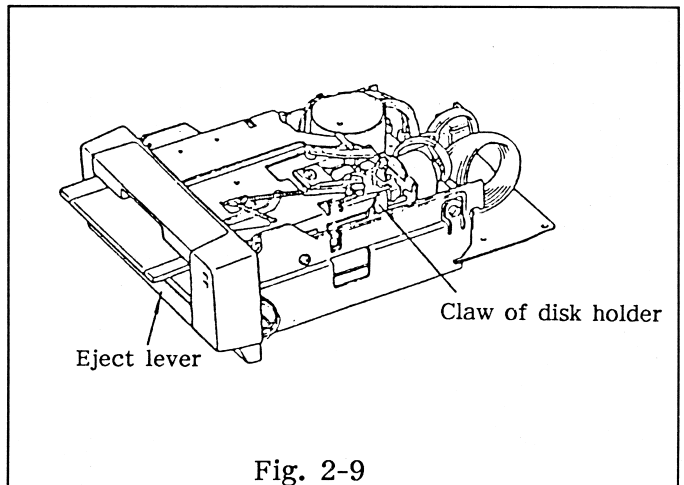
WRITE PROTECT TAB (WRITE PROTECT SENSOR)

The disk has a slide type protector. By sliding this to the open window, the disk is inhibited to write. This drive system has a write protect detect switch which detects whether or not the window is open.
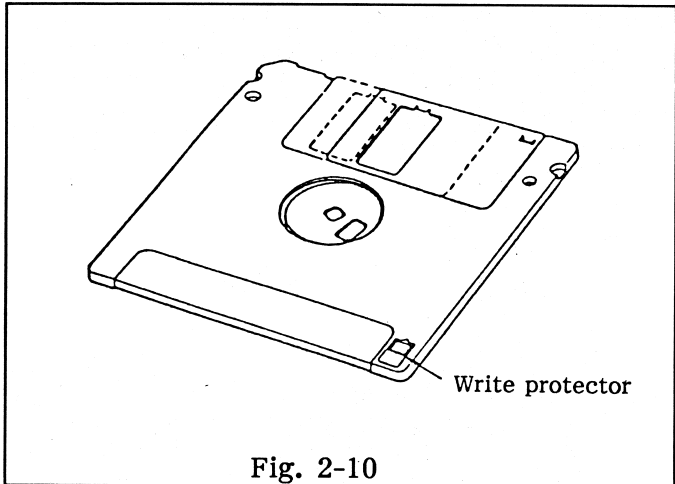

Fig. 2-10

INDEX SENSOR

This drive system requires a start mark (index signal) at read/write time. The index detection sensor detects the index signal via the notch in the disk support.
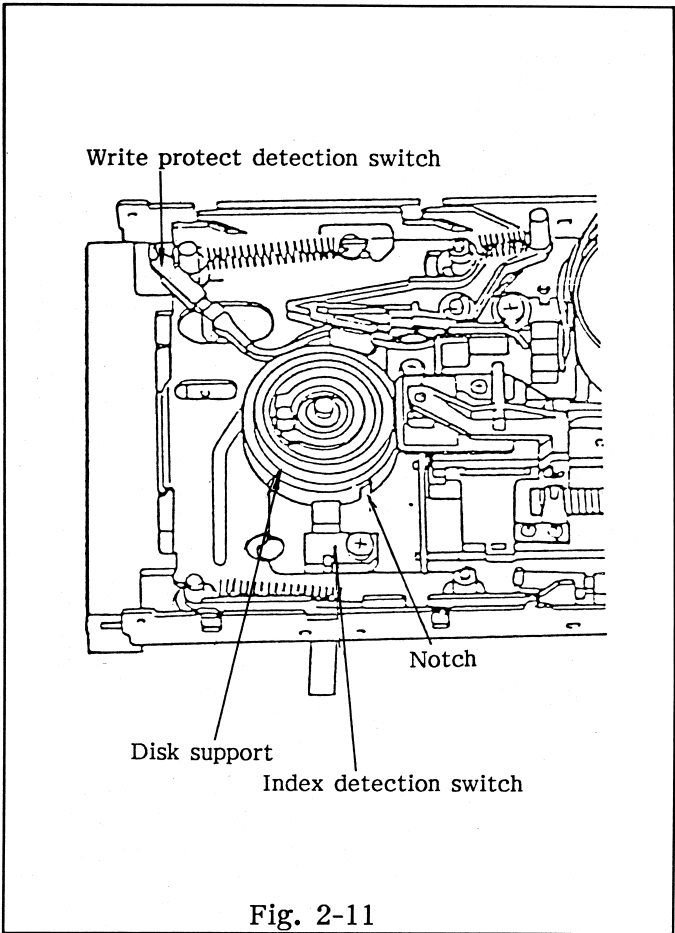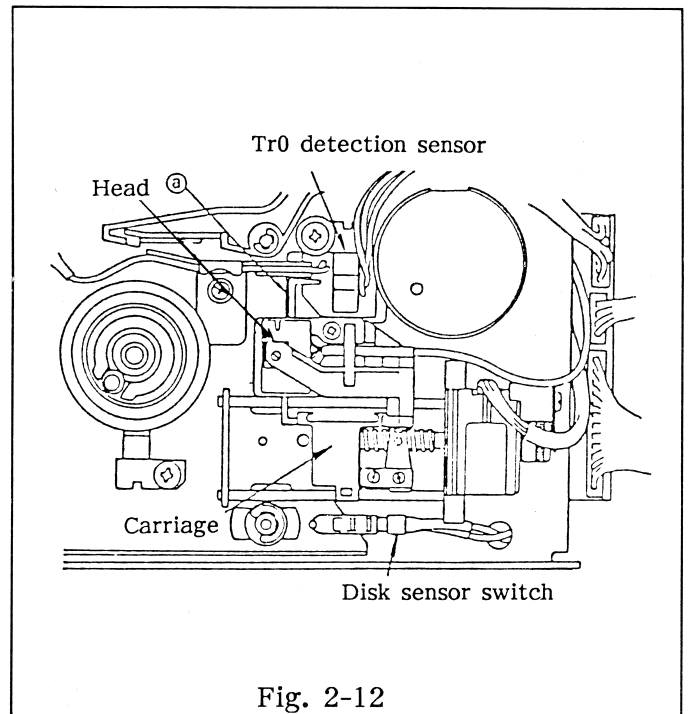

Fig. 2-11

MEDIA SENSOR

When the disk is inserted and chucked, the disk detection switch is pushed by the disk. This sensor detects whether or not the disk has been mounted.

Tr0 detection sensor

Head ⓐ

Carriage

Disk sensor switch

Fig. 2-12

RESTORE (ACTION FOR RETURNING THE HEAD TO HOME POSITION)

This drive system returns the head to Tr0 (home position) when the power is ON. Tr0 is positioned when a portion of the carriage closes a slit in the Tr0 detection sensor.

3 SPECIFICATION OF ELECTRIC CIRCUIT (CARTRIDGE, DRIVE A, DRIVE B)

CONFIGURATION OF ELECTRIC CIRCUIT

The electronic components can be roughly divided into Cartridge, Power Supply and Drive.

The cartridge performs control of the drive and the interface with MSX computer system.

The power provides supplies +5 V and +12 V to the drive. The drive part performs the control of the motor, write of the head and waveform adjustment of read signal.
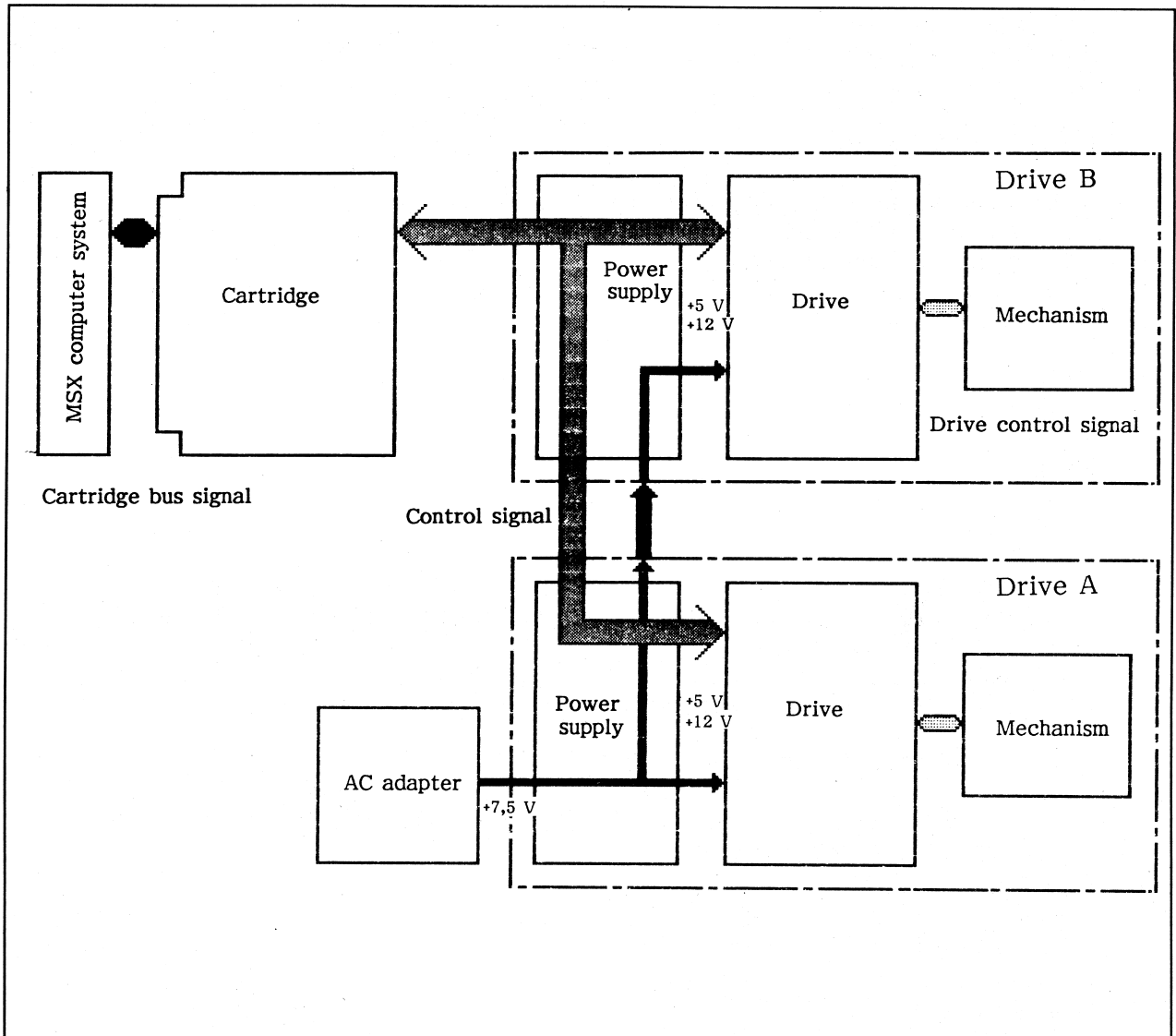
CARTRIDGE

(The circuit diagram of the cartridge is shown in the attached Figure 3-2.)

The circuit of the cartridge consists of PROM, FDC, VFO I/O port Decoder circuit and I/O buffer.
The description of parts as follows;

1) PROM (M5L27256)

This is a PROM compatible with Intel 27256 and incorporates the drive control program, MSX-Disk-Basic and MSX-DOS.
The CPU of the MSX computer system can read this ROM through the cartridge bus.

2) FDC (M5W1793-02P)

This is a floppy disk controller compatible with Western Digital FD1793-02.
This performs MFM modulation and demodulation of data, control of step motor, monitoring of drive sensor.

3) VFO (SED9420C)

This is a VFO type data separator, manufactured by SUWA SEIKOSHA.
This waveform adjustment of the read signal from the disk and convert it into window signal and regenerative read data signal. This prevents the decrease of read margin caused by change of rotation speed of DC motor and peak shift of read signal. The CLOCK of FDC is supplied from this IC.

4) I/O PORT (74LS175, 74LS365, 74LS74)

74LS175 is an output port. This port can control switching of the drive and ON/OFF of the DC motor.
74LS365 and 74LS74 are input ports. They detect the presence of the disk, whether or not the disk has been changed, or presence of data request of FDC.

5) DECODER (74LS30, 74LS138, 74LS32)

It allocates the proper address to PROM, FDC and I/O port. ROM is addressed 4000h -7FBFh and FDC 7FC0h - 7FDFh and BFC0h - BFDFh, I/O port 7FE0h - 7FFFh and BFE0h - BFFFh.

6) I/O BUFFER (72LS14, 7406 DTC114Y)

The output signal to drive is provided from the open collector and the input signal from drive can be received in the Schmidt trigger.
The input signal is pulled up by 1KΩ because the drive side output is the open collector.

POWER SUPPLY

The circuit diagram of the power supply for drive A is illustrated in Figure 3-3. The circuit diagram for the drive B illustrated in Figure 3-4.

The power supply of drive A consists of the constant voltage circuit which produces +5 Volts, from the AC adapter. The DC-DC converter circuit which converts +5 Volts, into +12 Volts and the signal pathes between the drive and cartridge.

Power supply of the drive B is the same as that of drive A mentioned above. The power for drive B is supplied from drive A.
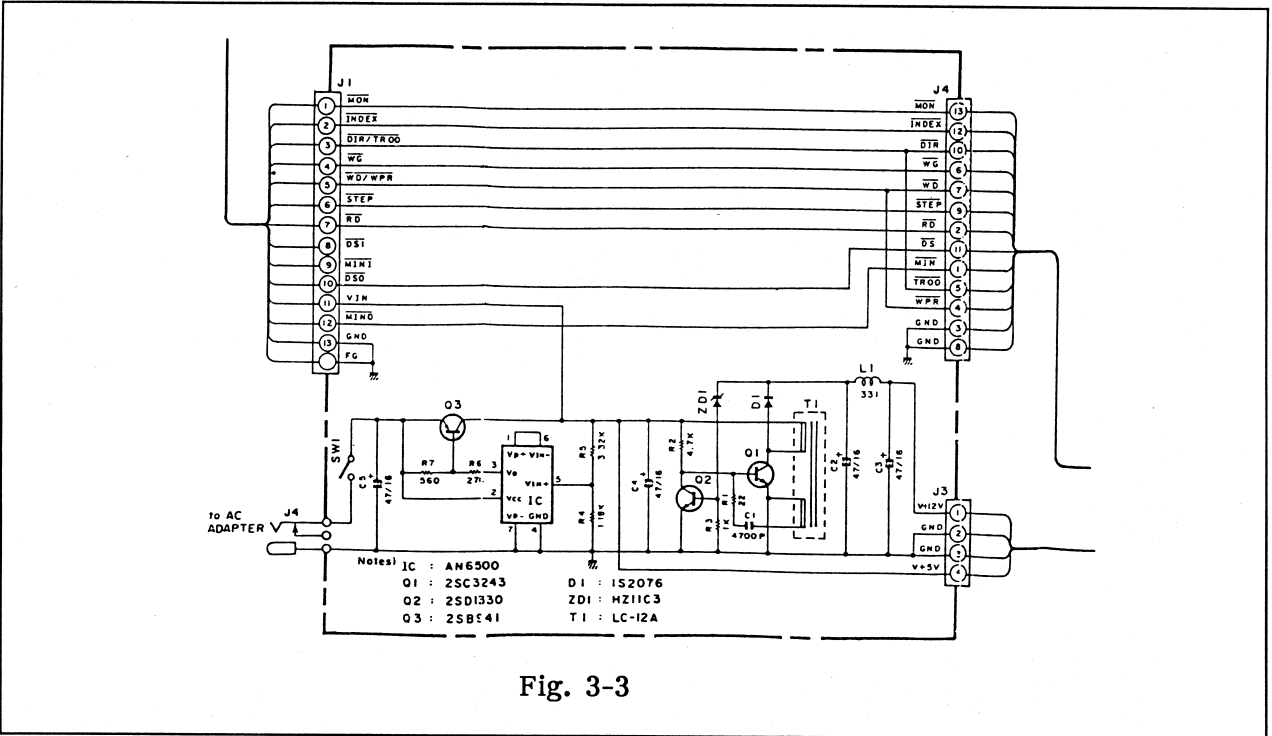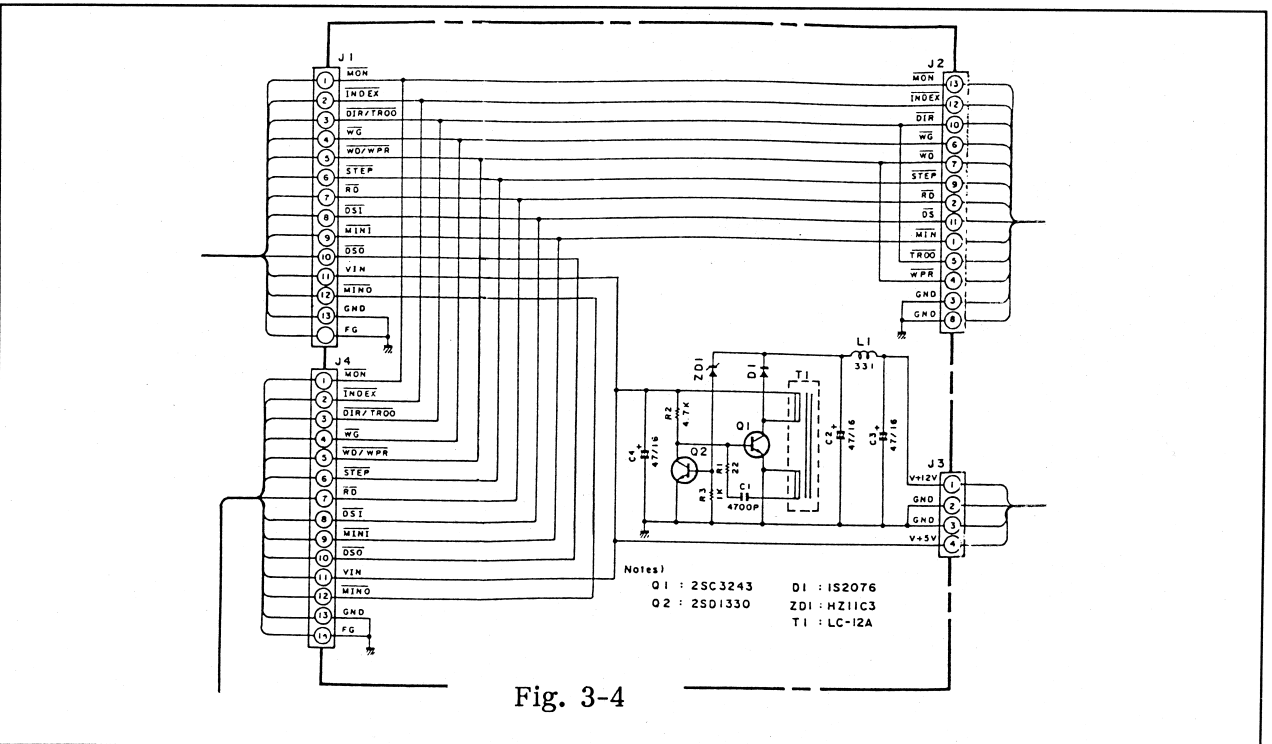

Fig. 3-3

Fig. 3-4

DRIVE (DRIVE BOARD)

As shown in Figure 3-5 block diagram, this board consists of an interface, read/write circuit, DC motor drive, stepper drive, LED and each sensor inputs.
The circuit diagram of the drive board is shown in the attached Figure 3-6. Terminal names and functions of the IC M51017AP for read/write/control are shown in Table 3-1.
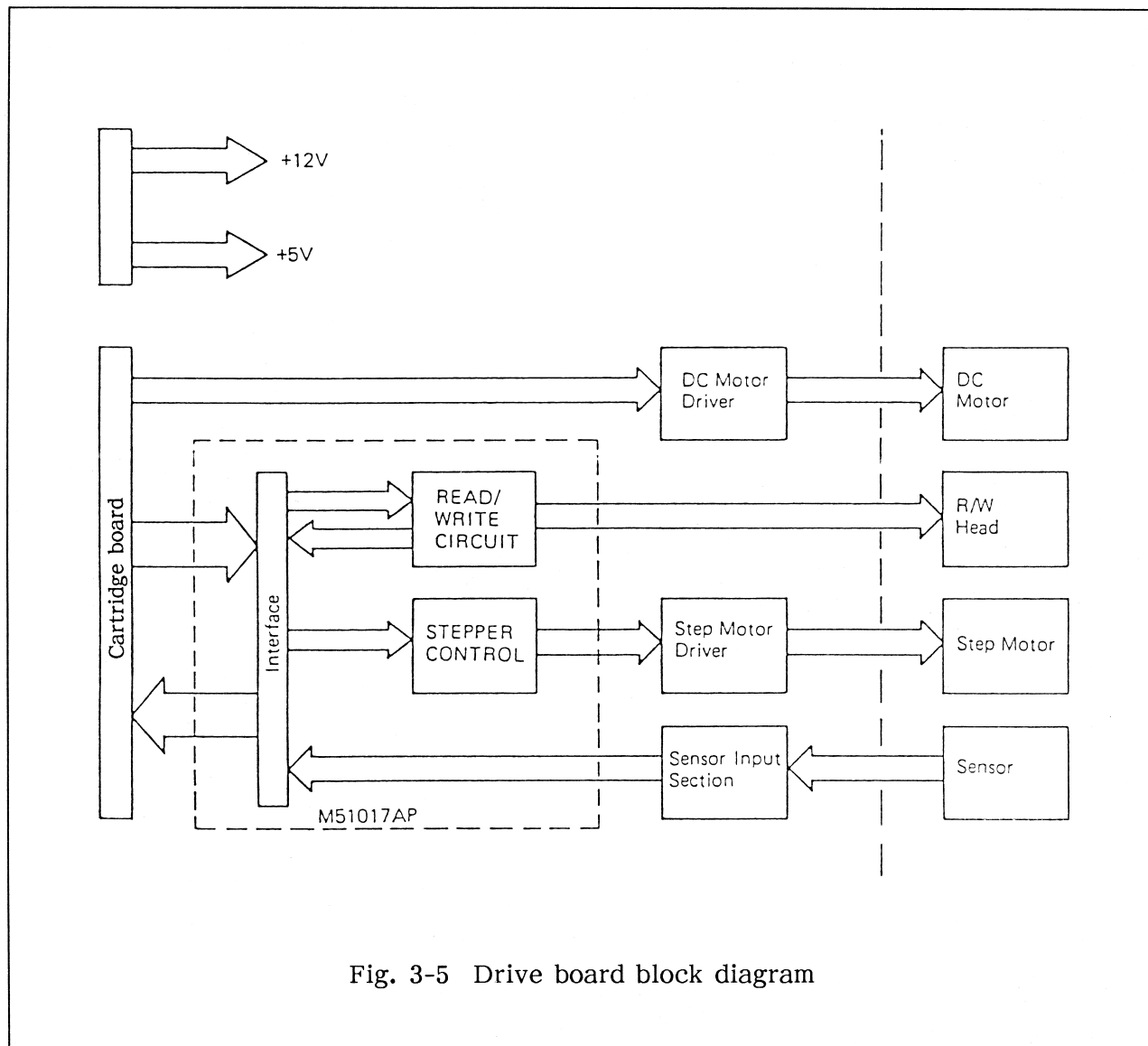

Fig. 3-5 Drive board block diagram

1) Interface section

This exchanges data between the cartridge board and the drive board through a buffer.

2) Read/write circuit section

Write circuit, read circuit and time chart during a read function are shown in Figure 3-7 to Figure 3-9 respectively.

* During writing
When WG (Write gate) signal is sent from the cartridge board it is an active (LOW), the write circuit enables the write mode and sends current to the head to write data on the media. R7 in Figure 3-7 sets the value of write current.

* During reading
Data picked up by the R/W head is amplifiered by a amplifier and the high-frequency noise is removed through a filter. Waveform adjustment is then passed through a differentiator to detect the position of the peak value a "RD" pulse is generated at zero-cross point of the output.
After comparator output, the timed main filter is provided to absorb saddle ($\triangle$T of Figure 3-9).
In the circuit diagram (Figure 3-8), R11 and C8 set the time constant of the timer main filter and R12 and C9 set the width of RD pulse.
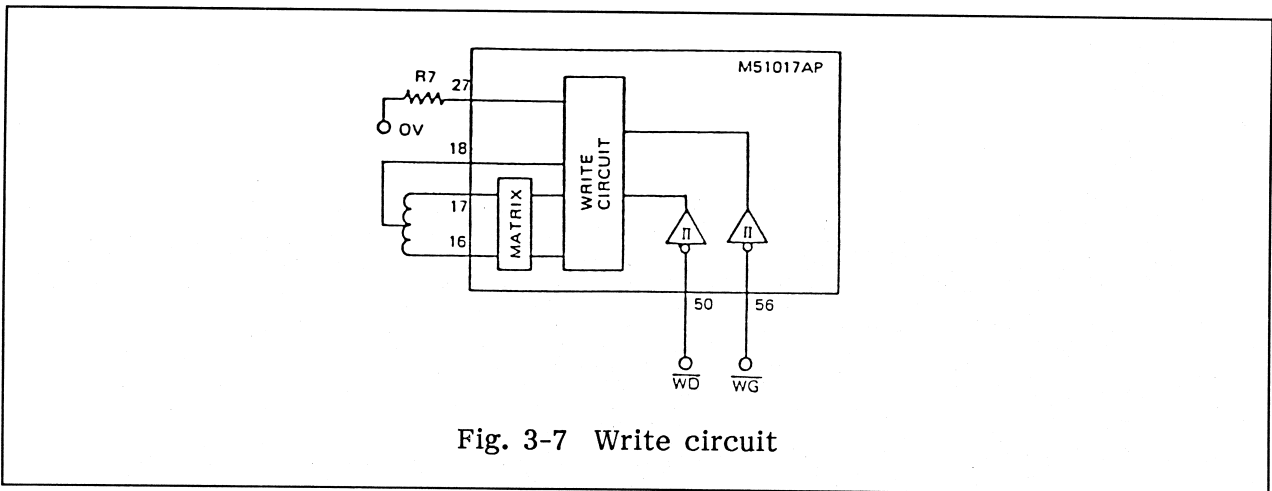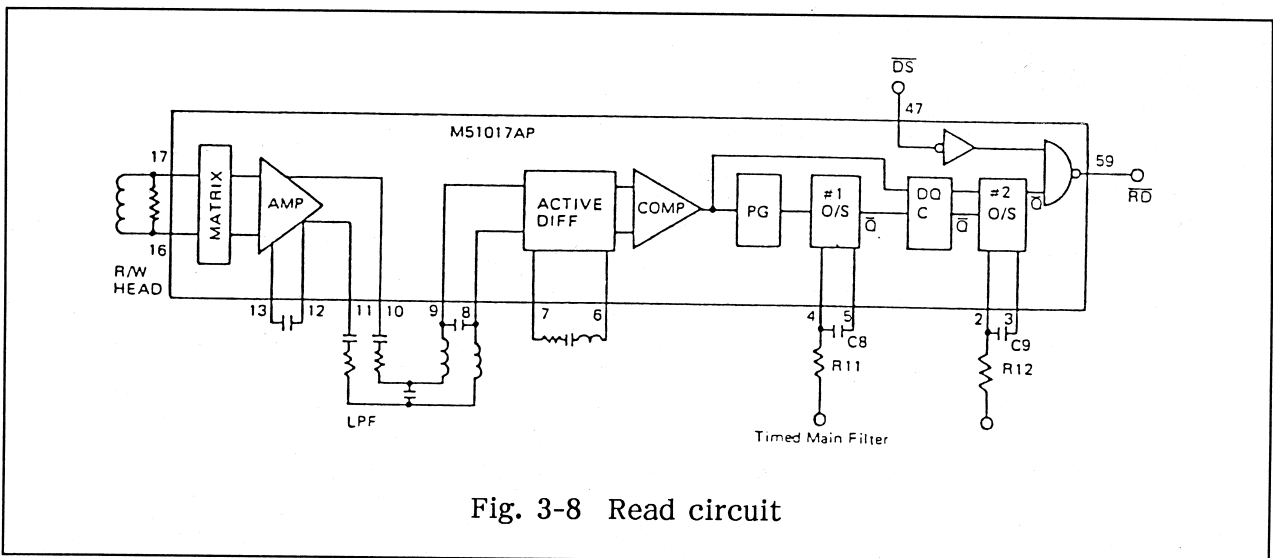
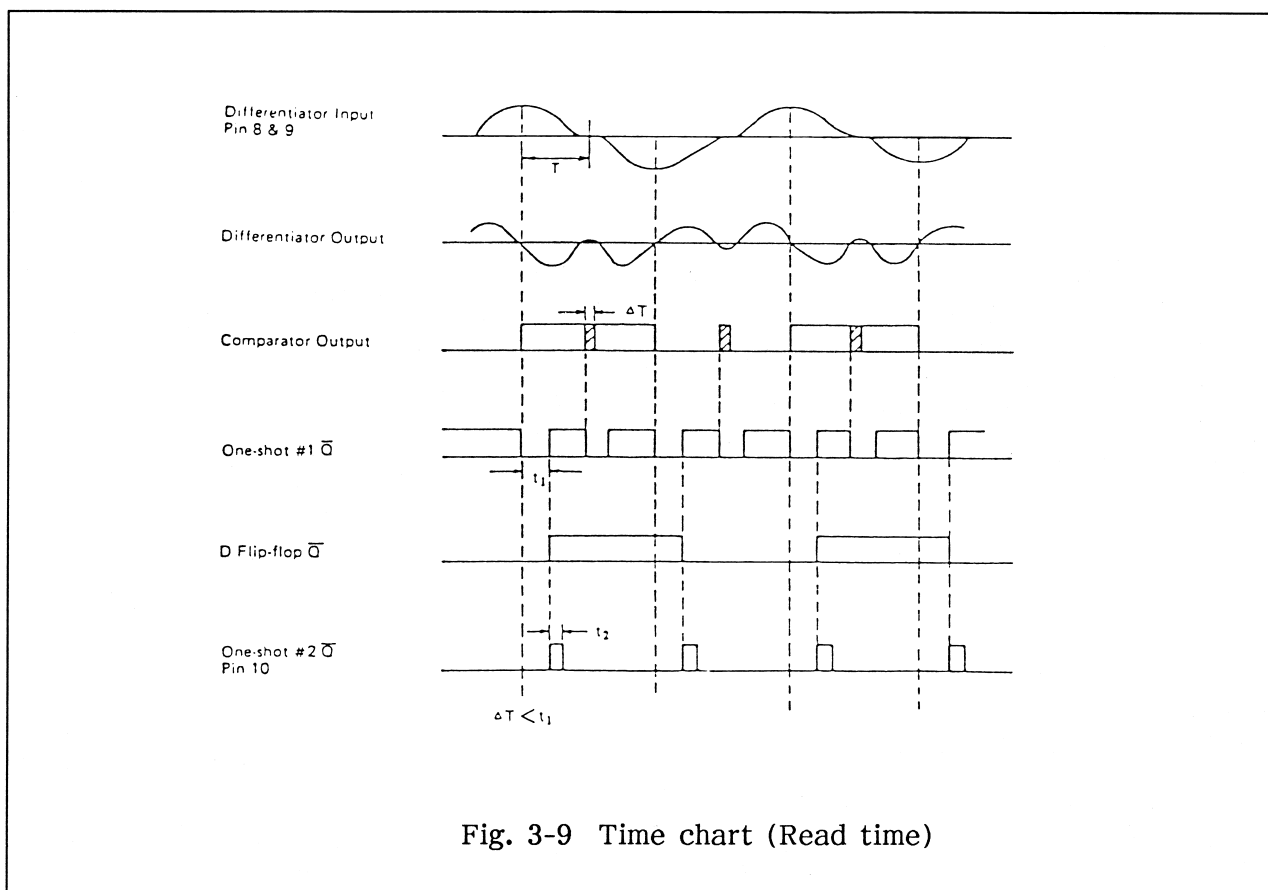Fig. 3-7 Write circuit

Fig. 3-8 Read circuit

Differentiator Input Pin 8 & 9

Differentiator Output

Comparator Output

One-shot #1 $\overline{Q}$

D Flip-flop $\overline{Q}$

One-shot #2 $\overline{Q}$ Pin 10

$\Delta T < t_1$

Fig. 3-9 Time chart (Read time)

Table 3-1 (a) M51017AP pin indication

Terminal Number	Name	Function
33	Vcc	5V Power Supply
19	V_{BB}	12V Power Supply
21 - 25	GND	Ground (Analog system)
51 - 55	GND	Ground (Digital system)
18	CT.0	Terminal to supply WRITE current and ERASE current at WRITE
16. 17	READ 0	Input/output terminal for READ/WRITE signal to HEAD
12. 13	OFFSET DECOUPLING (GAIN ADJ)	Controls a gain of READ amplifier
10. 11	AMPLIFIER OUTPUT	Output terminal for preamplifier
8. 9	ACTIVE DIFFEREN-CIATOR INPUT	Input terminal for differenciator
6. 7	DIFFERENCIATOR COMPONENT	Terminal to adjust a peak shift externally
4. 5	M/M COMPONENT	Sets a time constant of monostable multi-vibrator to prevent a wrong output of READ data.

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Terminal Number	Name	Function
2. 3	M/M/ COMPONENT	Sets a time constant of monostable multi-vibrator to set the output pulse width of READ data.
27	WRITE CURRENT ADJ	Terminal to set WRITE current
44	INUSE LED	"L", when DRIVE SELECT (47 pin) is at "L".
46	INDEX	"H", when INDEX SENSOR (41 pin) is at "L".
57	TRACK 0	"L", when TRACK 0 SENSOR (41 pin) is at "L" and pulse output "A" (39 pin) of a stepping motor drive is at "H".
58	WR PROTECT	"L", when WPT SENSOR (42 pin) is at "L".
59	RD DATA	Output terminal for READ data OFF at WRITE and ERASE.
40 39 38 37	STEPPER DRIVE PULSE	A $\overline{A}$ B $\overline{B}$ — Generates a two-phase exited drive pulse. 1 step and 1 pulse when STEP SWITCH (30 pin) is at "L", 1 step and 2 pulse when it is at "H".
47	DRIVE SELECT	Terminal to indicate the select state of a drive unit. Selectable at "L".
48	DIRECTION	Input terminal to specify the head travel direction. "L" for a center direction, "H" for a pheripheral direction
49	STEP	Input terminal to generate a pulse to drive the head. Blocked at WRITE.
50	WR DATA	Input terminal for record data.
56	WR GATE	Becomes the record effective with "L" input.
43	INDEX SENSOR	Indicates the rotation state and accept input every rotation. INDEX (46 pin) is at "L" when INDEX SENSOR is at "H".
42	WPT SENSOR	Input terminal to decide whether or not writing data on the disk is possible. WR PROTECT (58 pin) is at "L" when WPT SENSOR is at "L".
41	TRACK 0 SENSOR	Input terminal to indicate the head is on TRACK 0. TRACK 0 (57 pin) is at "L" when TRACK 0 SENSOR is at "H".
35	RESET	Input terminal for POWER ON RESET. Initialises each M/M at "H".
30	STEP	Input terminal to select 1 step and 1 pulse or 1 step

3) DC motor drive (Spindle motor circuit)

The circuit diagram is shown in Figure 3-10.
"MON" signal sent from the cartridge causes Q10 to toggle ON or OFF, and the DC motor to start or stop.
Q11 is always OFF and is turned ON if overcurrent flows, this limits the current into the motor.
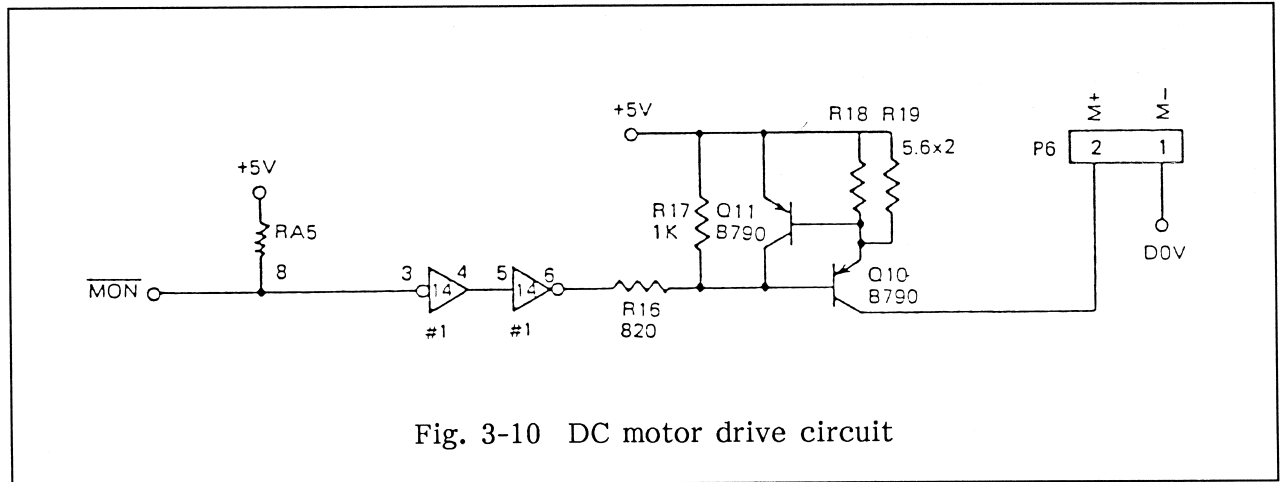

Fig. 3-10 DC motor drive circuit

4) Step motor drive

The circuit diagram is shown in Figure 3-11 and the timing chart is shown in Figure 3-12.
This converts $\overline{STEP}$ and $\overline{DIR}$ signals sent from the cartridge board. The signal for driving bipolar through a stepper control in IC (M51017AP) passes the current to the STEP motor via the drive circuit.
L4 and C13 in the circuit diagram are filters for removing noise.
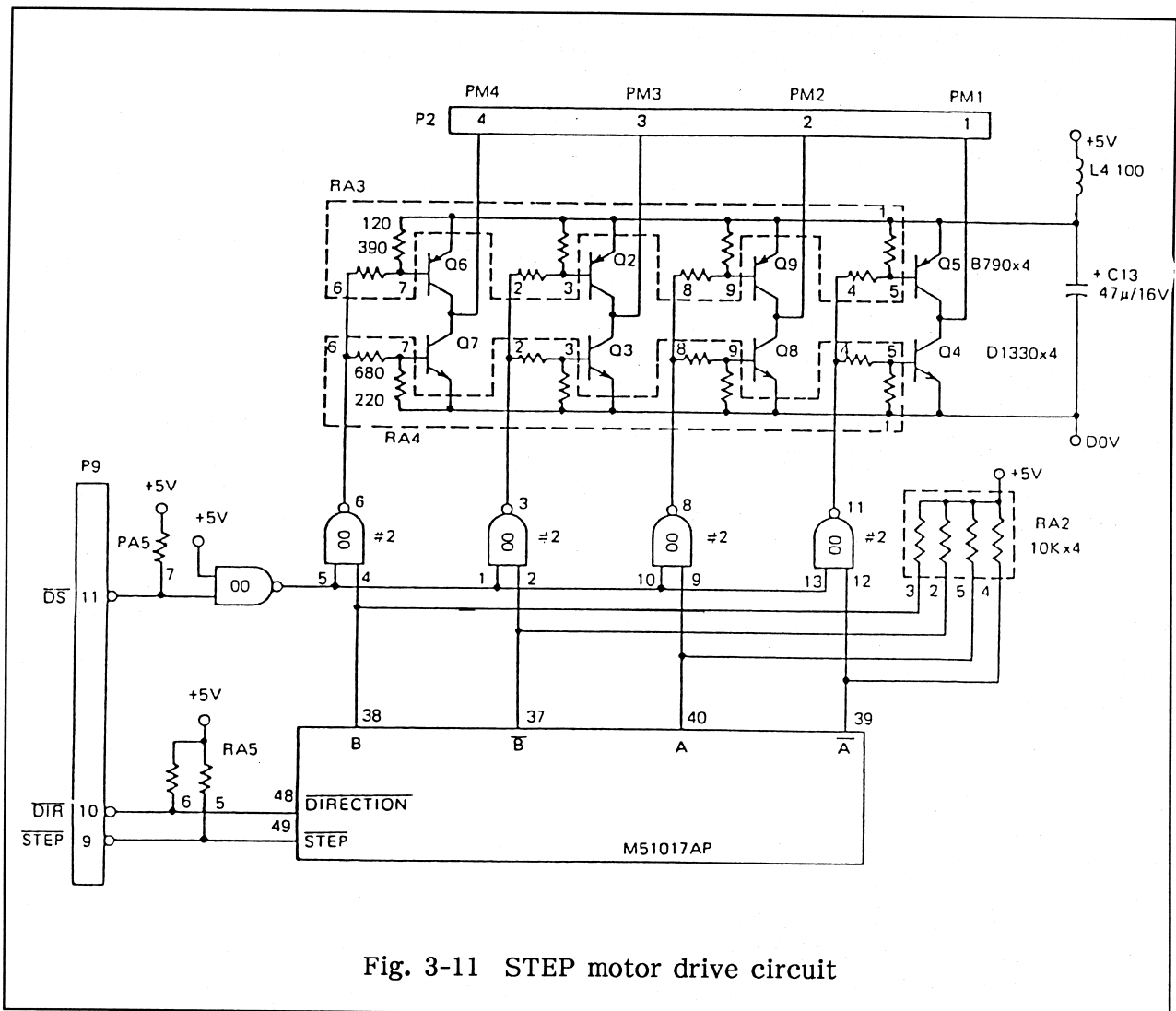When the drive is not selected, the gate input prevents the current from flowing to the STEP motor.
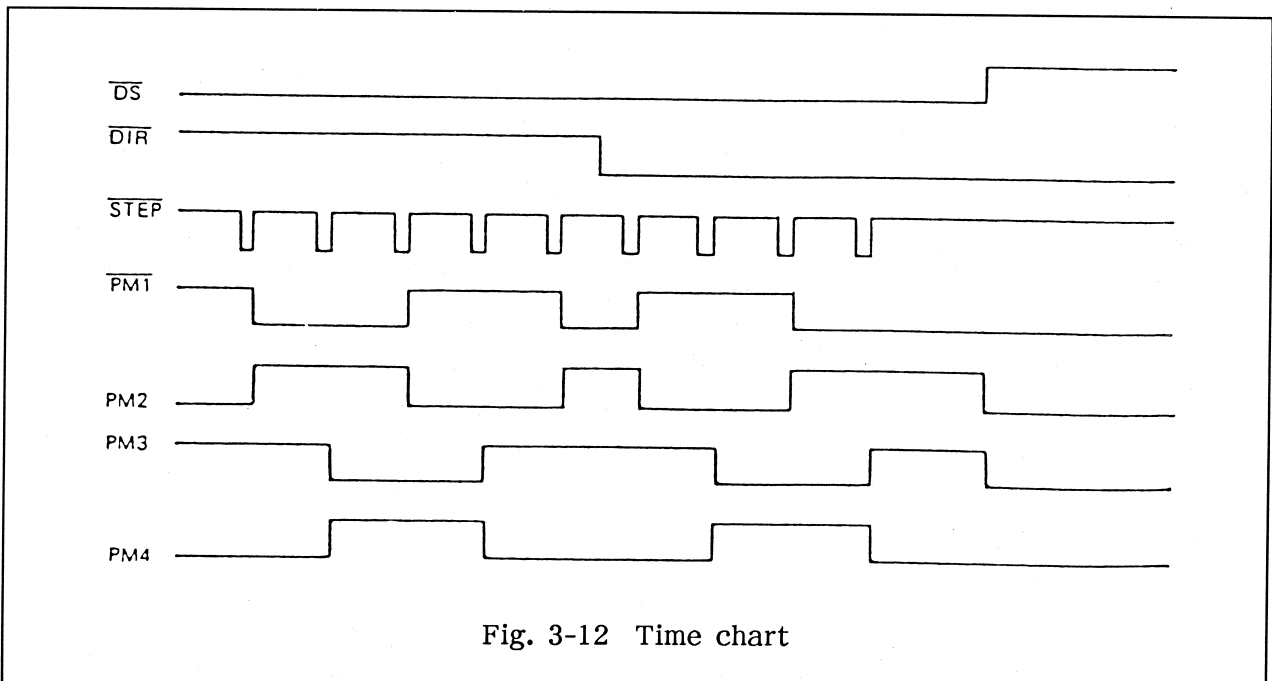
Fig. 3-11 STEP motor drive circuit

Fig. 3-12 Time chart

5) Sensor input section

The circuit diagram is shown in Figure 3-13.
It inputs, "INDEX" and "Track 0" Write protect signals from each sensor and send it to IC (M51017AP), through invertor IC's as shown.
In the IC, the gate input is made so that the signal is passed to the cartridge only when DS (drive select) is active. " Media In" signal is applied direct, without any inversion.
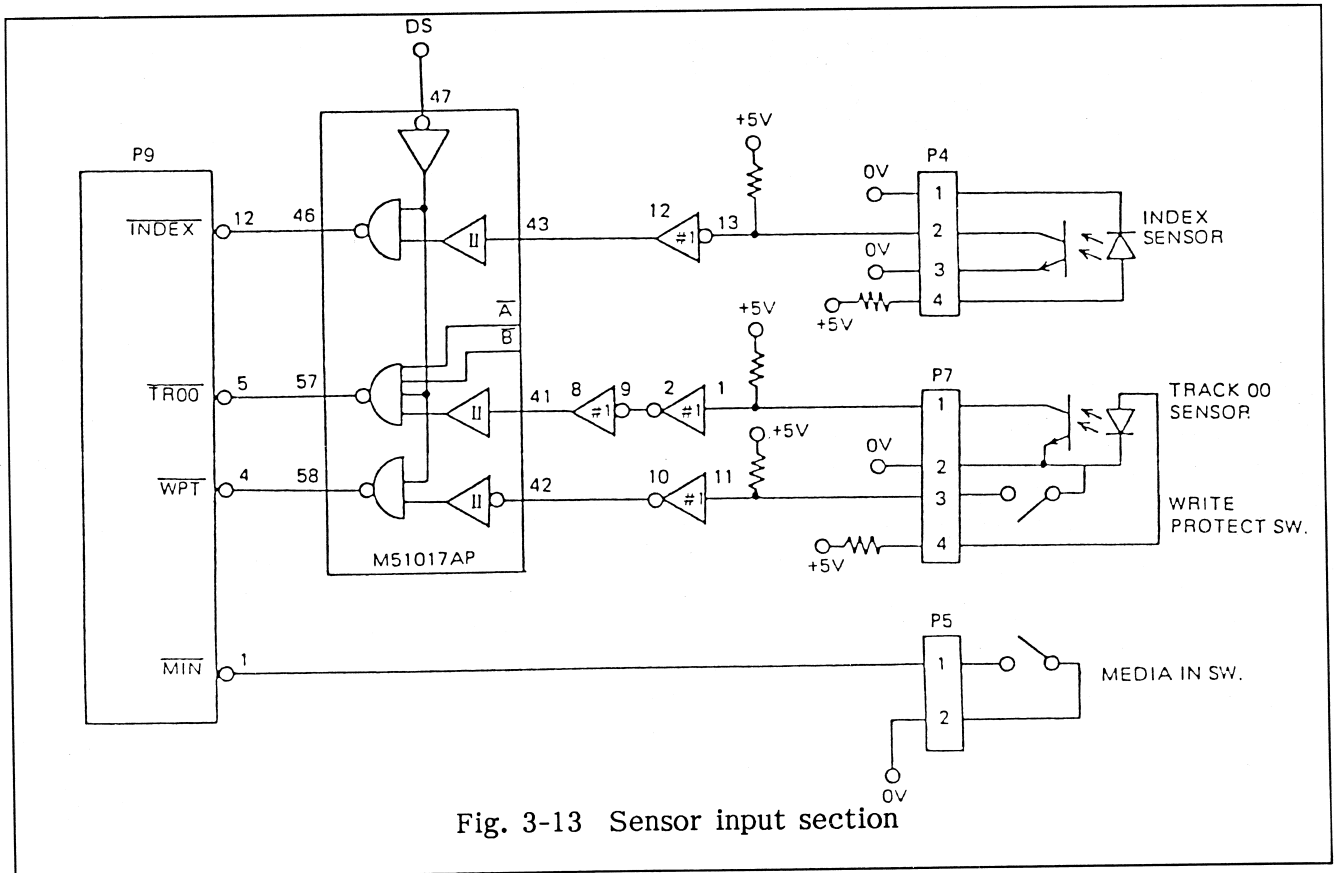

Fig. 3-13 Sensor input section

Description of each sensor

* INDEX Signal for detecting the rotation starting point of media, it is output according to the timing chart shown in Figure 3-14.
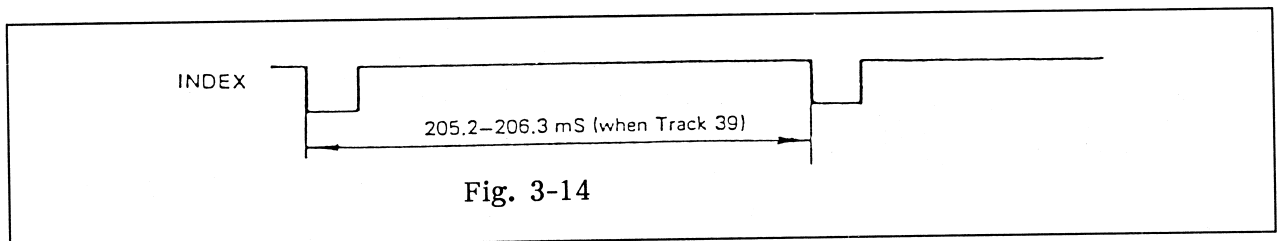

Fig. 3-14

* Track 0 Indicates R/W head is on Track 0.
* Write protect Detects the state of the write protect notch and inhibits data from being written.
* Media In Checks whether or not media is inserted in the drive.

6) LED

POWER LED is illuminated when the power is "ON", and the "IN USE LED ON" when the drive is selected.

GENERAL PROCEDURE

This section explains the basic procedure of the control program for the drive, locate in the cartridge ROM.

1) Drive select, motor ON/OFF

Drive selection is made by activating DS0 or DS1.
Both drives may not be selected at the same time.
Motor "ON" is made before selection of the drive. After motor ON, about one second is used as wait time.
After finishing access of the disk, the motor stops in about three seconds.

2) Restore

This signal will restore the head position with reference to the track 0 sensor. The head is first moved inward till the "Track 0" signal becomes non-active. Then it is moved outward and stopped when the "Track 0" signal becomes active.

3) Seek

Seek moves the head to a destination track, controlled by the step motor. After setting the PIRC signal to an appropriate polarity, a proper number of 4 μs wide pulses are output to the STEP signal in a 6 ms interval.

4) Read

This signal allows data to be read from the disk.
When the Read command is passed to FDC, the FDC performs MFM modulation of the RD signal from the drive and control program receives to stores the signal in RAM of MSX computer system.

5) Write

This signal allows data to be written onto the disk.
The program sends the Write command to FDC and the FDC receives data complying with its request. The FDC performs MFM modulation of data and outputs a WD signal to the drive. The drive section receives this data and stores it on the disk.