Chapter 8

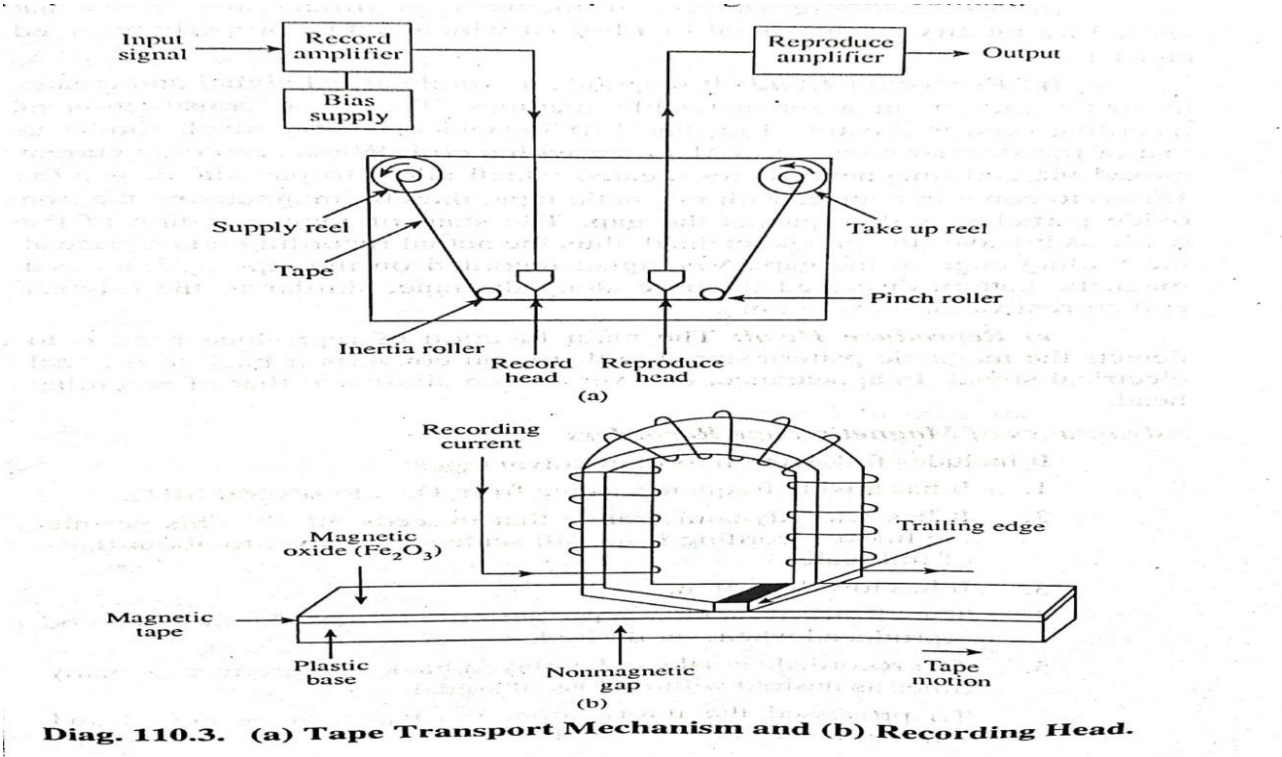
Output Devices

1. Indicating Instruments:

- Indicating instruments are those which indicate the instantaneous value of the electrical quantity being measured at the time at which it is measured.
- Their indication are given by pointers moving over calibrated over calibrated scale.
  Examples: Ammeter, Voltmeter, wattmeter, etc. (Details in Chapter 5)

2. Magnetic Data Recorder:

- It is used to record analog data in such a way that can be retrieved or reproduced in electrical form again.
- The most common and most useful way of achieving this is via the use of magnetic tape recording.
- The basic components of a tape recorder are:
  i. Tape transport mechanism
  ii. Magnetic Tape
  iii. Conditioning Device
  iv. Recording Head
  v. Reproduce Head



Diag. 110.3. (a) Tape Transport Mechanism and (b) Recording Head.

i. Tape Transport Mechanism:

- The main function of this mechanism is to move the tape along the recording head or reproduce head at constant speed.
- Also the mechanism must be capable of handling the tape during various modes of operation without straining, distortion or wearing of tape.
- The mechanism must use an arrangement to guide the tape past the magnetic heads with great precision, maintain proper tension and obtain sufficient tape to magnetic head contact.

ii. Magnetic Tape:

- It is composed by coating fine magnetic iron oxide particles [Fe_2O_3] on a plastic ribbon.
- A typical size of tape is 12.7mm wide and 25.4 μm thick.
- The magnetic particles conform to magnetic pattern get induced in them and retain it.

iii. Conditioning Device:

- It includes amplifier and filters that needed for modifying the signal to a format which can be properly recorded on a tape.

iv. Recording Head:

- It responds to an electrical signal and creates magnetic pattern on a magnetisable medium.
- When recording current passed via coil, magnetic fluxes is created which pass via air gap (5 – 15 μm) to come in contact with magnetic tape, thereby magnetizing the iron oxide particles as they passes the gap.
- The state of magnetization of the oxide as it leaves the gap is retained, thus the actual recording takes place at the trailing edge of the gap.
- Any signal recorded on the tape appears as a magnetic pattern dispersed in space along the tape, similar to the original coil current variation with time.

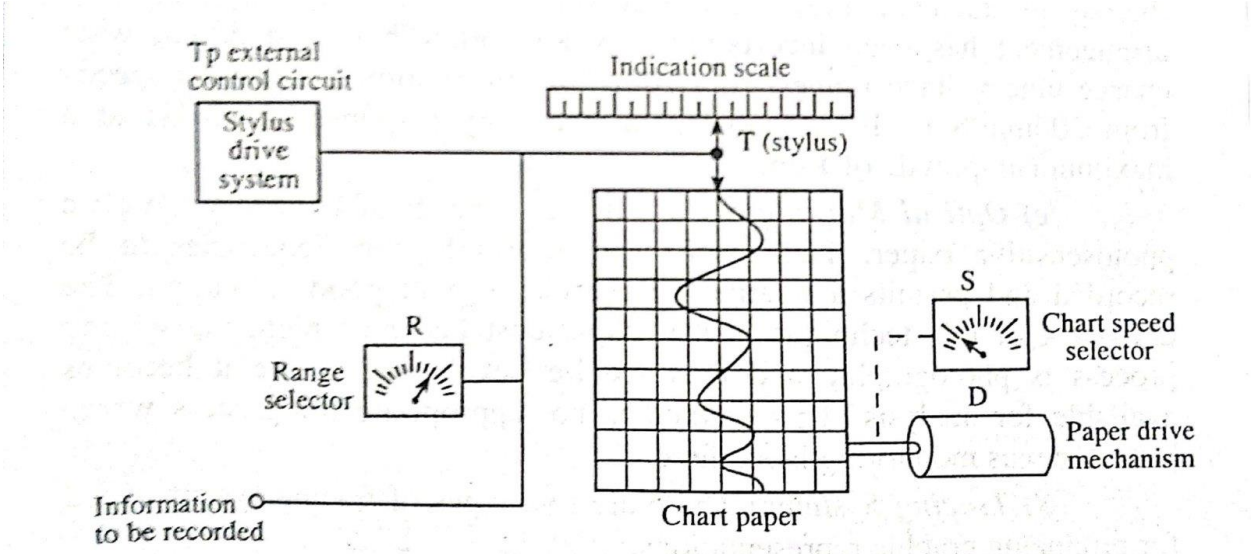
v. Reproduce Head:

- Detects the magnetic pattern stored in them and converts it back to original electrical signal. In appearance, it is very similar to that of recording head.

Advantages of Magnetic Tape Recorder

- It has a wide frequency range.
- It has wide dynamic range that exceeds 50dB. (Full scale to 0.3% of full scale).
- It has low distortion.
- The electrical input signal stored in magnetic memory can be reproduced whenever desired.
- The recorded signal can be played back or reproduce as many times as desired without loss of signal.
- The tape can be reused and reused to record a new set of data.

3. Strip Chart Recorder:



Diag. 110.1. Strip Chart Recorder

Working:

- It consists of a long roll of graph moving vertically.
- This paper is driven by a drive system D and the speed of this drive system get controlled by chart speed selector S.
- Chart speed of 1 – 100 mm/sec is usually used.
- A stylus T is used for marking on the moving graph paper and this stylus move horizontally in proportional to the quantity being recorded.
- A stylus driving system moves the stylus in a nearly replica or analog of the quantity being recorded.
- A range selector switch R is used so that input to the recorder drive system is within the acceptable level.
- Most recorder use a pointer attached to the stylus.
- This pointer moves over a calibrated scale thus showing the instantaneous value of the quantity being recorded.

A. Paper Drive Systems:

Its main function is to move the paper at a uniform speed. Synchronous motors are widely used.

B. Marking Mechanism:

There are various types of mechanisms used for marking marks on the paper but most commonly used ones are:

a) **Marking with Ink filled Stylus:**
The stylus is filled with ink by gravity or capillary actions. The stylus moving over the paper with printed scales traces the variations of the input signal. Low cost and little friction between the stylus tip and the paper. However, this mechanism has drawback that ink splatter at high speed, batches at low speeds and clogs when stylus is at rest.

b) **Marking with Heated Stylus:**
The heated stylus melts a thin white wax like coating on a black paper base. Special paper so high cost. Cannot be used in the process producing heat. But quite reliable and yields high contrasts traces.

c) **Electric Stylus Marking:**
It employs a paper with a special coating which is sensitive to current. In this method, when current is conducted from stylus to the paper, a trace appears on the paper. Wide range of marking speeds, low stylus friction and long stylus life. But high cost of paper.

d) **Electrostatic Stylus:**
It produces a high voltage discharge thereby producing a permanent trace on an electro sensitive paper.

e) **Optical Marking Stylus:**
It uses a beam of light to write on a photosensitive paper. This mechanism allows higher frequencies to be recorded and permits a relatively large charts with good resolution. High paper cost and not suitable for instantaneous monitoring.

C. Tracing Systems:

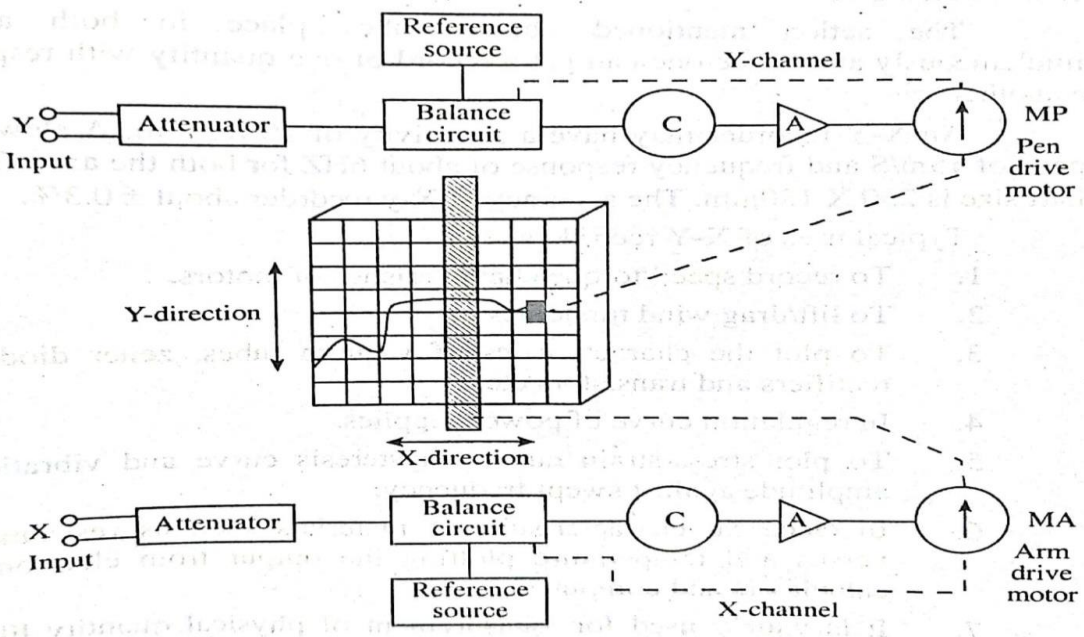
There are two types of tracing systems used for producing graphic representations

a) **Curvilinear System:**
It uses stylus mounted on a central pivot and moves via an arc that allows a full width chart marking. If the stylus makes a full range recording, the line drown across the chart will be curved and the time intervals will be along this curved segments. This type of system is used on many records with PMMC galvanometers actuating the stylus filled with ink. This method has drawback that the charts are difficult to analyze because of curved time base lines.

b) **Rectilinear System:**
A chart in which a line of constant time is perpendicular to the time axis and therefore this system produces a straight line across the width of chart. Here the stylus is actuated by a drive cord over pulleys to produce the forward and reverse motion as determined by the drive mechanism. The stylus may get activated by self-balancing potentiometer system, or a photo electric deflection system, a photo electric potentiometer, or a bridge balance system. The mechanism is usually used with a thermal or electric writing.

4. X - Y Recorder:

- It provides a graphic record of relationship between two variables.
- In X – Y recorder an emf is plotted as a function of another emf which is accomplished by two self-balancing potentiometer controlling the position of (rolls) paper and recording pen (stylus) respectively.
- The measured emf may be the output of a transducer that may measure displacement, force, pressure, strain, light intensity or any other physical quantity.
- Thus, with the help of X – Y recorders and appropriate transducers, a physical quantity can be plotted against another physical quantity.



Diag. 110.2. X-Y Recorder.

Working:

- The main function of attenuator is to bring the input signals to the levels acceptable by the recorder.
- The signals enters each of the two channels and signals are get attenuated to the inherent full scale range of the recorder.
- The signal then passes to balance circuit where it is compared with an internal reference voltage.
- The error signal (i.e., difference between the input signal voltage and the reference voltage) is fed to a chopper circuit 'C' which converts the DC signal to AC signal.

- The signal is then amplified by amplifier 'A' in order to actuate servomotors MP and MA which is used to balance the system and hold it in balance as the value of quantity being recorder changes.
- This above actions takes place in both axes simultaneously hence one quantity get recorded w.r.t another.

Uses:

- To record speed/ torque characteristics of motors.
- To lift/drag wind tunnel test.
- To plot the characteristics of vacuum tubes, zener diodes, rectifiers and transistors, etc.
- In regulation curve of power supplies.
- To plot stress-strain curves, hysteresis curve and vibration amplitude against swept frequency.
- In electrical characteristics of materials such as resistance versus and temperature plotting the output from electronic calculators and computers.
- It is widely used for measurement of physical quantity like force, temperature, pressure, stress, strain and light intensity, etc.