

Display Devices & Recording Devices.

Display devices

"The results of measurement system must be displayed for instant observation through display devices"

Recording devices

"The results of measurement system must be stored for observation at a later stage through recording devices called recorder

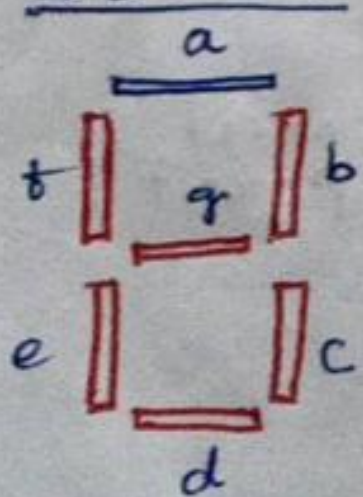
character formats:

- * Alphanumeric displays mainly displays alphabets & numerals for the various electrical inputs.
- * LED's & CRT's are used for displays.
- * Read only memories (ROM) are used for generation of alpha-numeric characters
- * Segment & dot matrix displays are the two types used for representation of alphanumeric characters.

i] segment displays:

- * There are 3 types
 - i) 7 segment
 - ii) 14 segment
 - iii) 16 segment depending upon whether it is numeric or alphanumeric display.

i] seven segment display:-

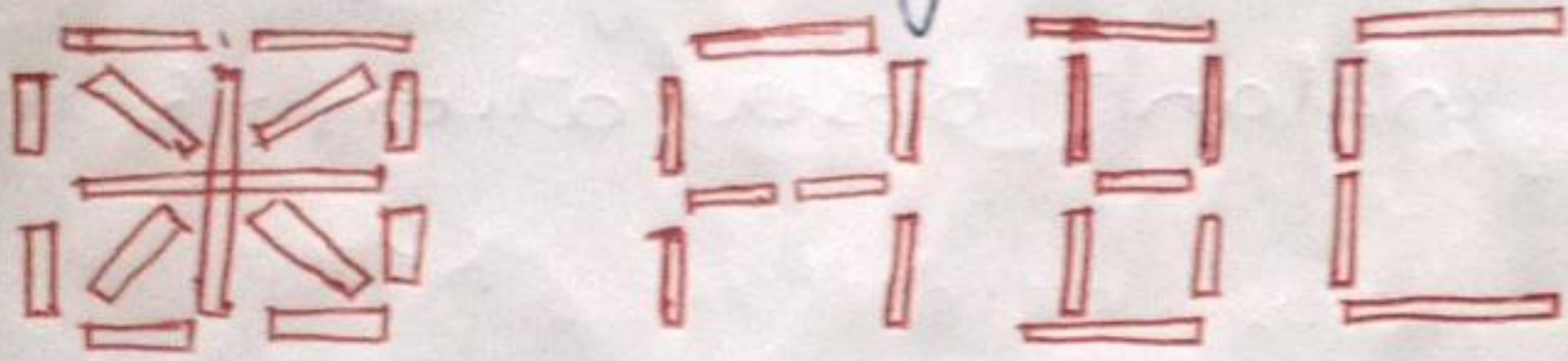


- * It is used for numeric display
- * It consists of 7 segments like a, b, c, d, e, f, g
- * In this it illuminates the proper groups thus digits to be displayed
- * By doing so we can display 0 to 9 numbers
- * It requires about 10 to 50mA current

when LED's are used.

* Even LCD's are also used for segment display.

i) Fourteen segment display:



- * It is used for alpha-numeric characters (both alphabets & numerals)
- * A, B, C are illuminated

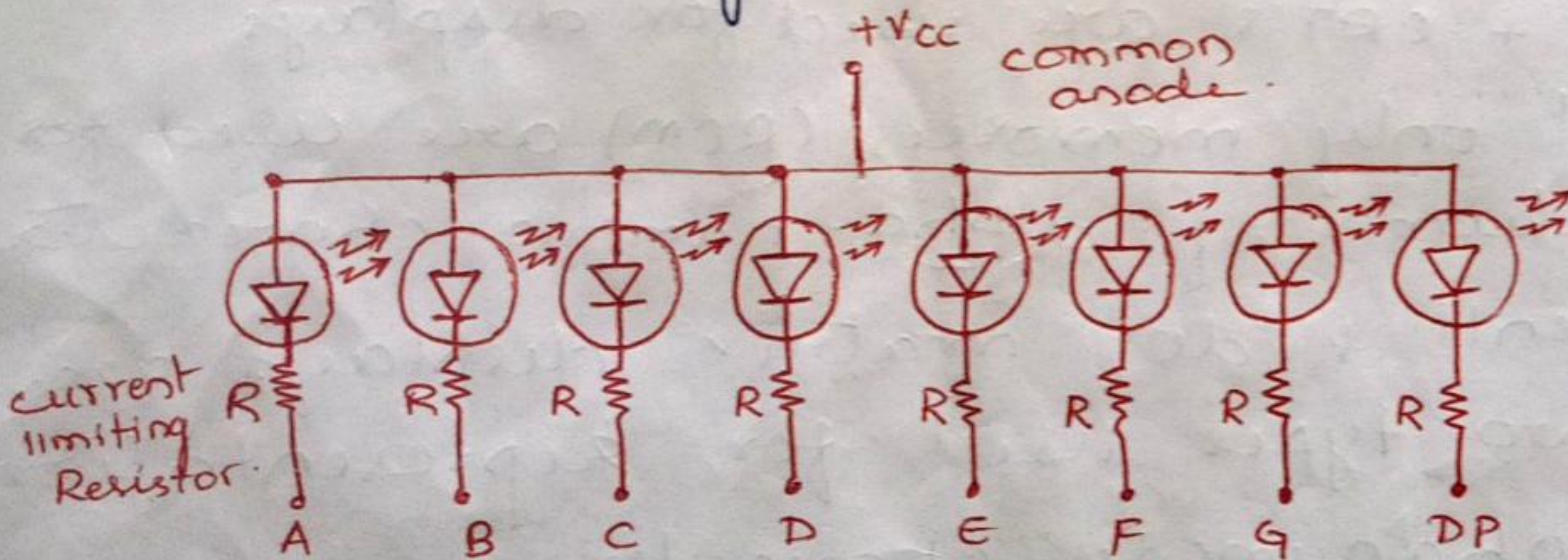
by illuminating of proper segments.

* In seven segment displays there are 2 types

- ① common anode type
- ② common cathode type.

* i) common anode type:

• All anodes of LED's are connected together & the common point is connected to $+V_{cc}$ & current limiting Resistor is connected between each LED & ground.

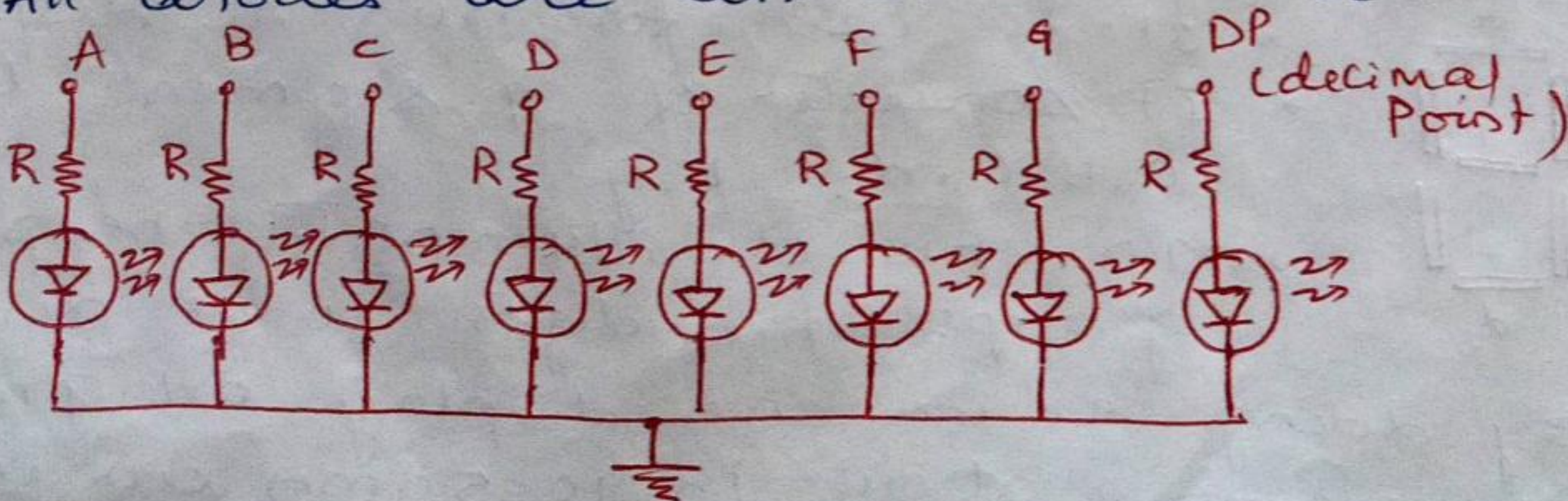


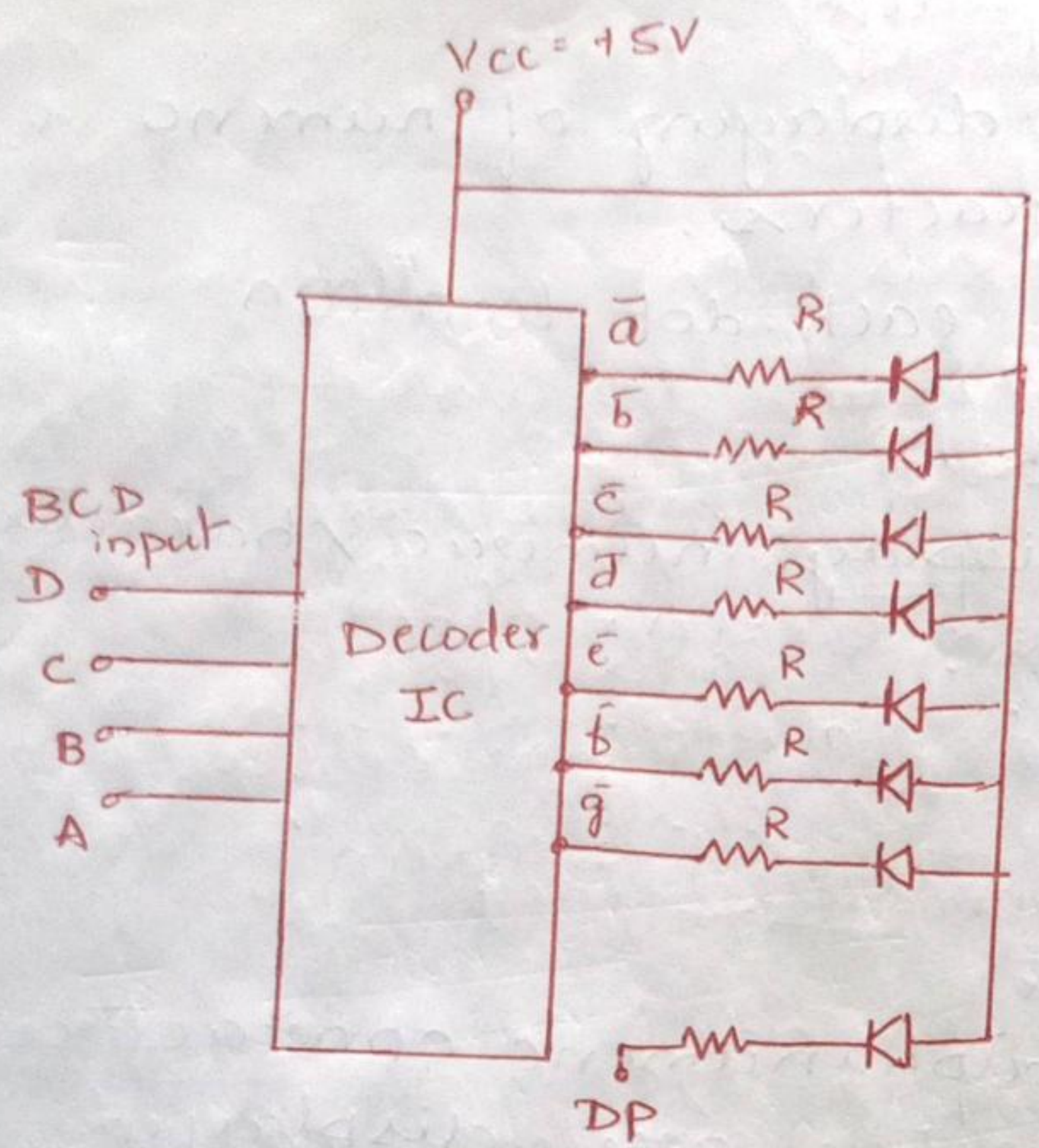
ii) Common Cathode type:

• In this type all cathodes of LED are connected together to common point & common point is connected to ground.

* current limiting resistor is connected to each LED & $+V_{cc}$ supply.

* All anodes are connected to $+V_{cc}$.





- * Common anode LED's are connected to active low decoders & common cathode LED's are connected to active high decoders.
- * A series resistors are connected to corresponding LED's further additional LED is provided for decimal point.
- * let us assume $A = 0, B = 1, C = 0, D = 0$ which is the BCD for '6'.
with the input decoder outputs will be $\bar{a}, \bar{b}, \bar{g}, \bar{c}, \bar{d}$ & \bar{e} will be low thus current will flow through LED's thus digit '6' is displayed as \bar{b} is high its LED does not conduct

2] DOT Matrix displays

• It is used for displaying of numeric & alpha numeric characters.

• It uses LED at each dot location.

i] 3x5 Dot matrix:

• It is used to display numeric characters



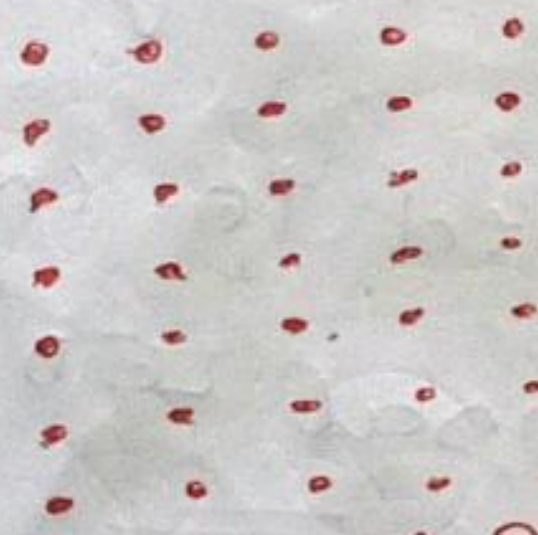
3x5 Dot matrix



numeric characters 1, 2, 3, 4

ii] 5x7 Dot matrix

• It is used for alphanumeric characters & also 192 characters are displayed in both upper case, lower case & greek symbols are displayed using this.



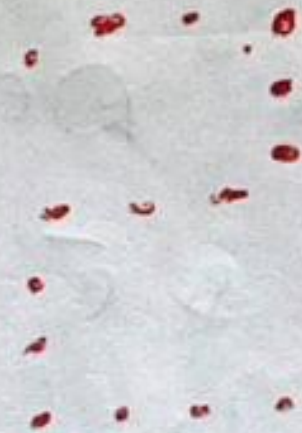
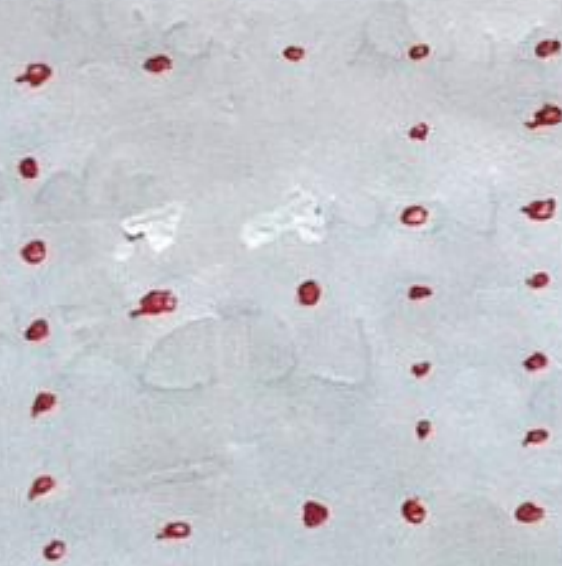
5x7 Dot matrix



Alphabet A

iii] Dot Matrix using 27 dots

• It is also used to display numeric characters.



• Dots may be square or round with 0-4mm side or diameter. here also LED & LCD are used for display of dots.

iv] 7x9 dot matrix format

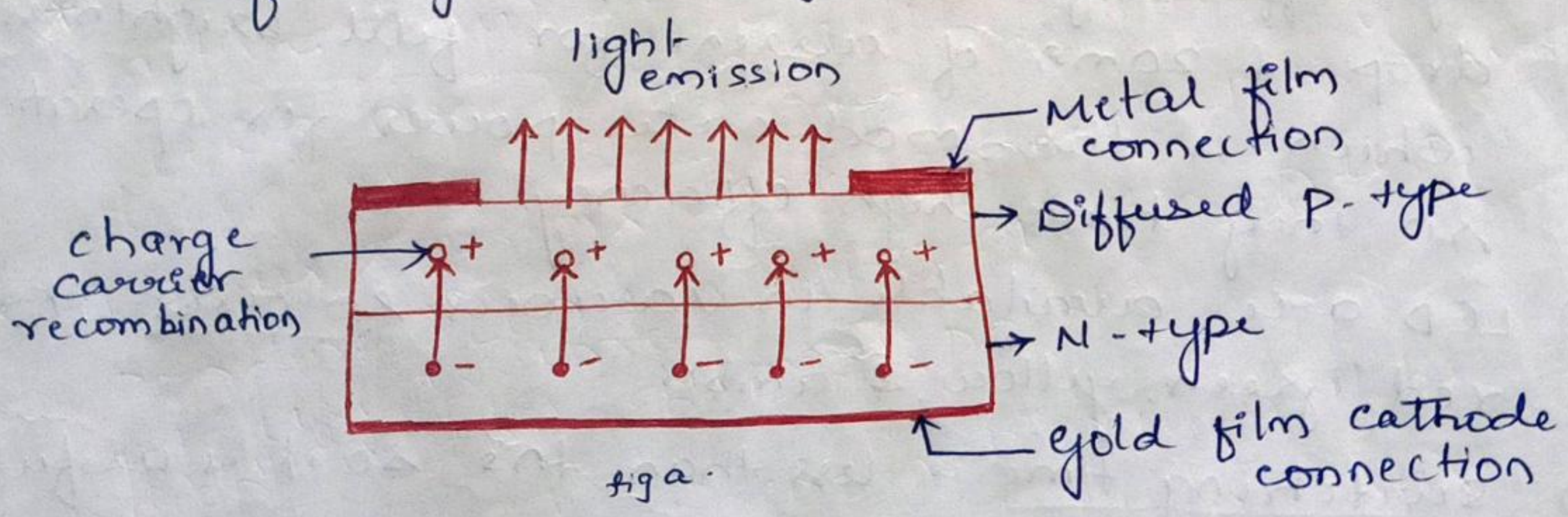
• It is used for better representation of lower case letters.

Light Emitting Diode (LED)

* LED is a PN junction device which emits light when a current passes through it in forward direction.

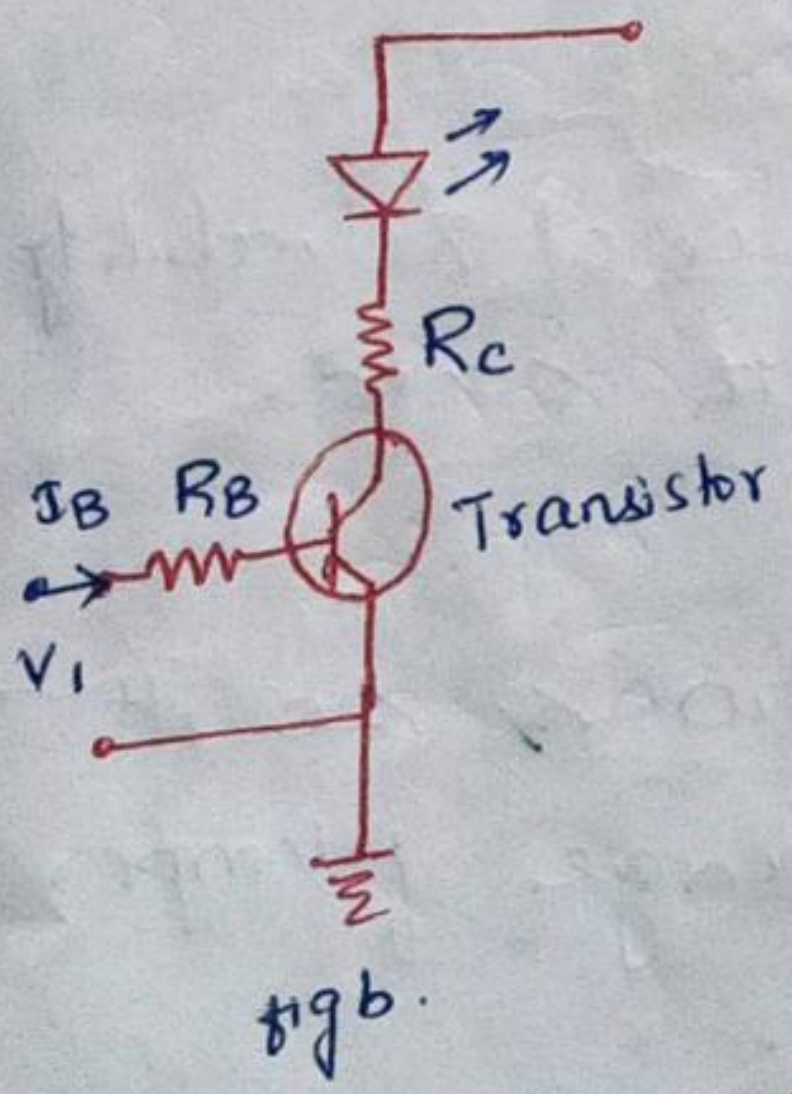
Construction

- Fig shows cross sectional view of LED
- It consists of two regions P type & N type in which N type consists of e⁻ as majority charge carriers & P type consists of holes.
- A metal film anode is deposited around the P type material which helps in maximum light emission.
- A thin gold film at the bottom of the N type is provided which helps in reflecting the light to the surface.



Working

- when electrons in N type cross & combines holes on p side then electrons^{carriers} holes charge recombination occurs at PN junction.
- when this recombination take place charge carriers give up energy in the form of heat & light.
- If the semiconducting material is translucent then light is emitted.



* fig b shows a simple transistor used for

OFF/ON of LED.

• when transistor reaches saturation state by I_B current then at this instant switch will be closed & the LED will emit light. LED light is limited by current limiting resistor R_c .

* ~~sem~~ GaAsP → Gallium arsenide phosphide
↓
emits red or yellow light
GaAs → gallium arsenide → green or red light.

* Advantages

- ① Miniature in size
- ② Intensity of LED is smoothly controlled as it is a function of current flowing through it can be controlled.
- ③ High efficiency: As LED require 1.2V of voltage drop & 20mA of current for full brightness which is the moderate power for operation so they have high efficiency.
- ④ LED are available in various colours like red, green, yellow, & amber.
- ⑤ switching time is less than 1ns so it is useful in dynamic operation.
- ⑥ They are economical & high degree of reliability as they are manufactured with same technology.
- ⑦ LED withstands shocks & vibrations, so it can be operated over wide range of temperature.

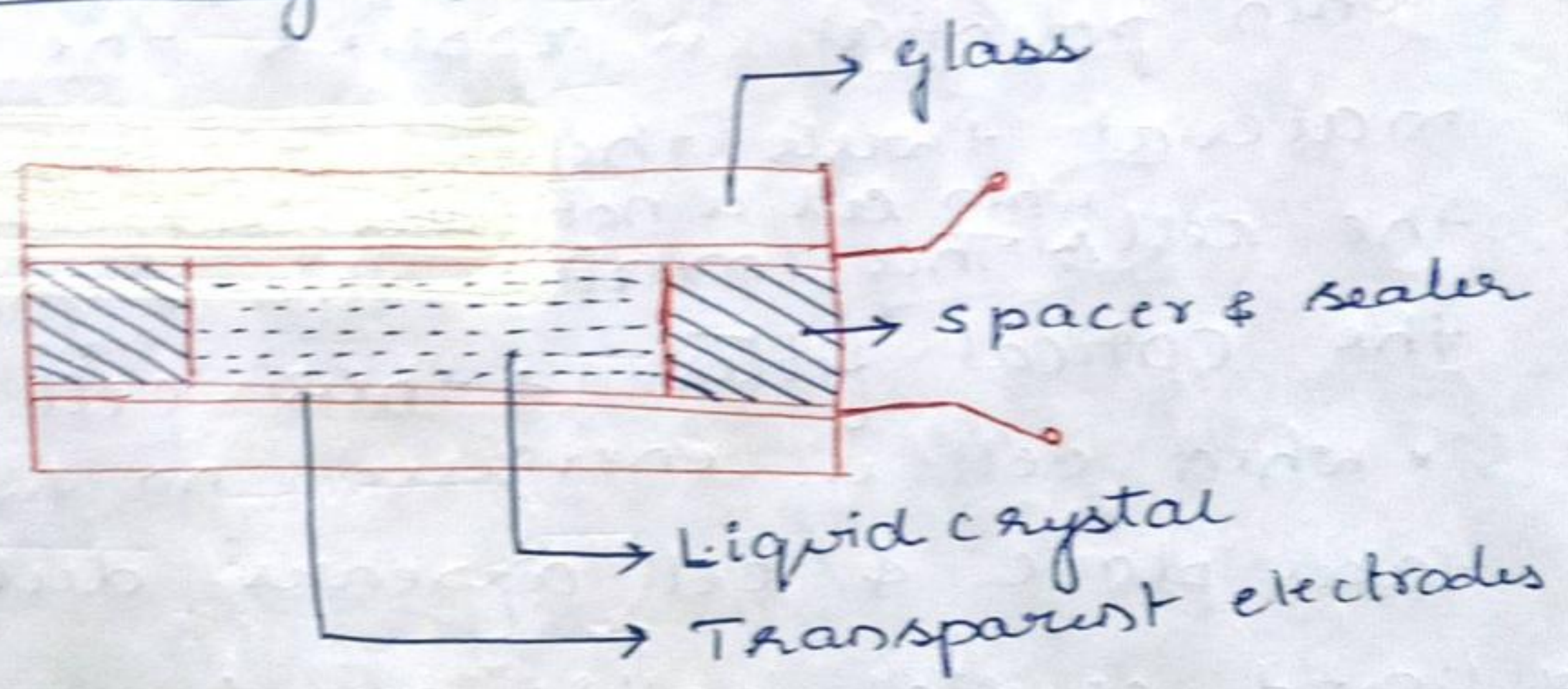
* disadvantages

- ① high power requirement than LCD
- ② not suited for large area display because of high cost.

Liquid Crystal Displays (LCD)

- * used for displaying numeric & alphanumeric characters in dot matrix & segmental display
- * There are two types of LCD's they are
 - ① Dynamic scattering type
 - ② Field effect type.

* Dynamic scattering type:-



- * Above figure shows dynamic scattering type.
- * Liquid crystal is placed between transparent electrodes.
- * Transparent electrodes are deposited on the inside ^{faces} of glasses.
- * Liquid crystal materials are organic compounds and they exhibit optical properties though they remain in liquid form.
- * When potential is applied across cell charge carriers flow through liquid which will disrupt liquid molecular alignment & produce turbulence. This will result in scattering of light in all directions thus cell appears bright.
- * If charge carriers are not activated then it remains transparent. This phenomena is called dynamic scattering.

* Field effect type:

- Its construction is similar to dynamic scattering type.

- * In this liquid crystal is placed between two thin polarizing optical filters.
- * optical filters are placed at the inner faces of glasses.
- * liquid crystal material is twisted nematic type
- * when potential is applied the liquid crystal material twists the light passing through the cell. ^{when cell is not energised,} This makes the light to pass through the optical filters & thus cell appears bright.
- * when cell is energised no twisting of light takes place & cell appears dull.
- * liquid crystal cells are two types.
 - ① Transmittive type &
 - ② Reflective type.
- * In transmittive type both glass sheets are transparent so light from source is scattered in forward direction when cell is activated.
- * In reflective type one glass sheet is reflecting source & other is transparent. when light incident on front surface it is dynamically scattered by activated cell.

Advantages

1. Have lower power consumption than seven segment & LED display

7 segment	requires	140 mW
LED	requires	40 mW
LCD	requires	20 mW.
2. Large display is possible
3. Low cost

disadvantages

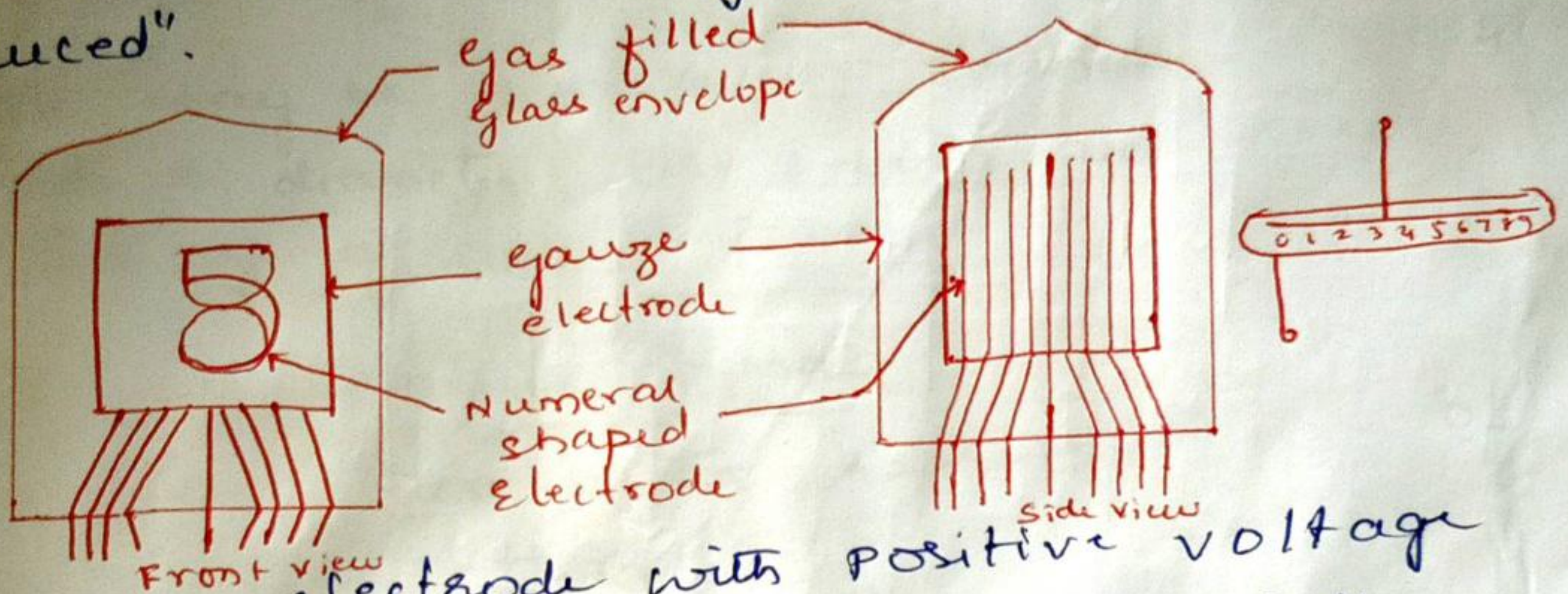
1. very slow devices - 'on' & 'off' time are quite large.

② when it is used on d.c their life span is quite small.

③ occupy large area.

Nixie tube or cold cathode display.

"It works on the principle that when a gas breaks down a glow discharge is produced".



* A gauge electrode with positive voltage supply acts as an anode & there are 10 separate wire cathodes i.e. 0 to 9. These electrodes are enclosed in gas filled envelope which have connecting pins at bottom.

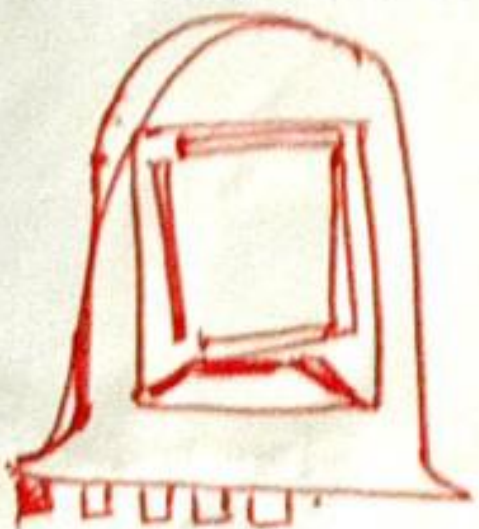
* In this neon gas is used which has orange-red glow.

* when negative voltage is applied to selected cathode & corresponding digit is lighted.

Modern Nixies:

* modern nixies have numerals 0-9 with that additional cathodes displaying decimal symbol + & - are also used.

* there are also special nixies which consist of 15 cathodes constituting 15 segments, which produces numerals as well as alphanumeric characters.



advantages

* simpler circuitry than 7 segment

disadvantages

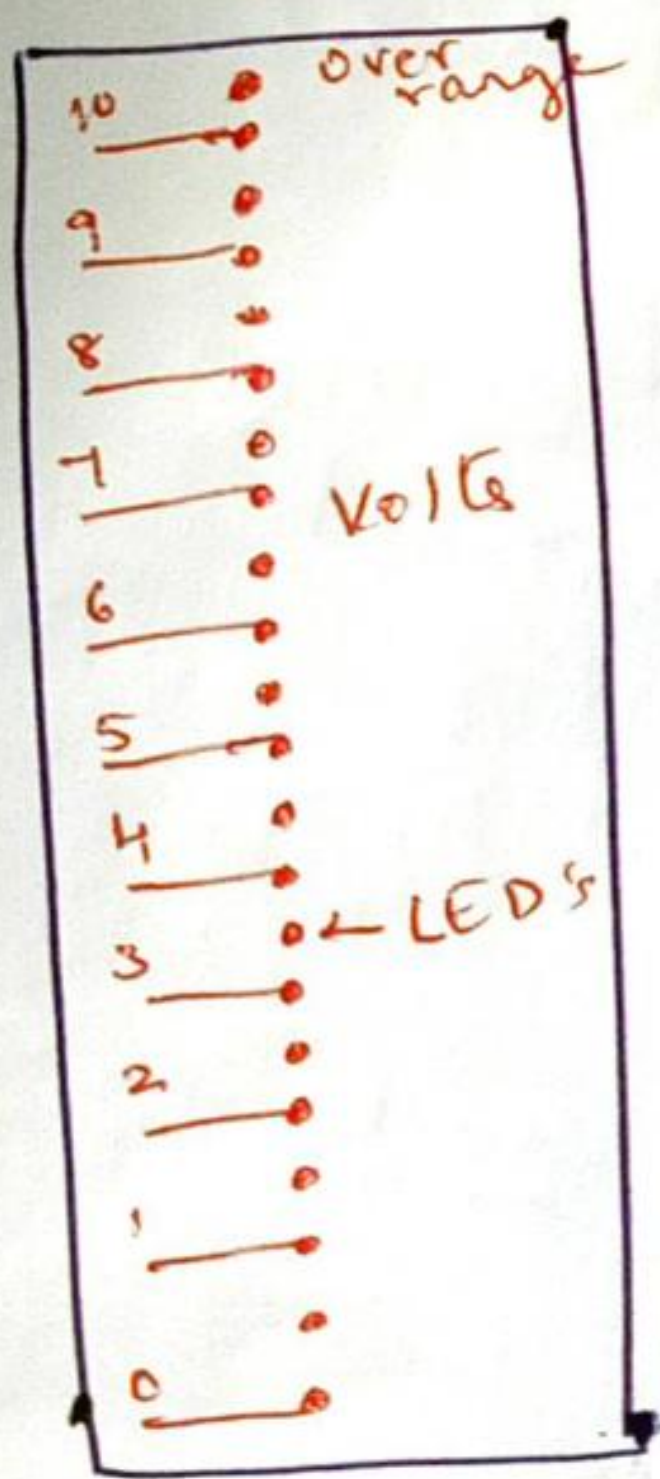
① High voltages are required for glow discharge

② Nixie tubes are bulkier in size

Bar graph display:

(5)

- * It is basically an array of LED, LCD or gas discharge panels which are arranged in $n \times m$ matrix.
- * the packed density is in 50 to 200 devices $/\text{cm}^2$ & its display as large as $50\text{mm} \times 100\text{mm}$.
- * Advantage is i) solid state nature & ii) good speed response
- * Application: panel meters - In this it accepts analog signal as input & gives equivalent display



Incandescent displays.

- * It is the basic process of producing light.
- * It can be done in wide range of sizes & colours.
- * Due to drawbacks new methods & materials improved reliability of such systems.
- * Some new methods are
 1. Incandescent display with seven segment filament enclosed in a single vacuum envelope.
 2. Incandescent display with 16 segment & 5x7 dot matrix display having thin microelectronics are presently available for alphanumeric display.

* Advantages

- ① Bright output
- ② simple technology
- ③ compatibility with IC's

* disadvantages

- ① very low operating speeds.
- ② multiplexing is not advantages as it needs diode for each display segment to avoid leakage path.
- ③ poor reliability due to failure of segment.

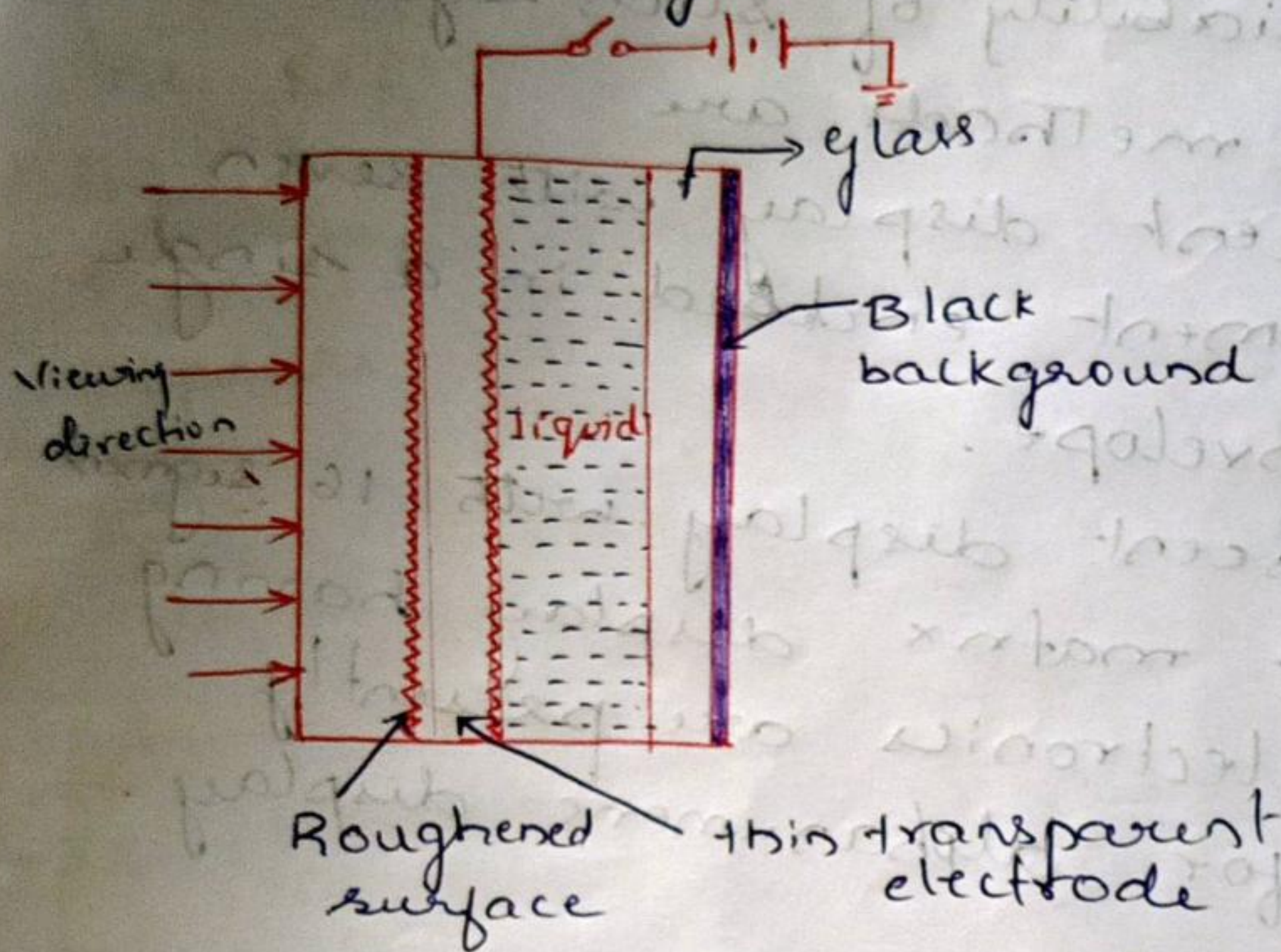
Fluorescent Displays.

- * These displays are mainly employed in calculators.
- * In this display it allows multiplexing requirement as it has low current & low voltages.

* Its typical colour is blue green.

Liquid vapour displays (LVD)

"Main principle is reflective passive displays depend on lights on the surrounding of their working"



* Above fig shows the typical LVD cell.

* It consists of two glass plates front plate & back glass plates

* The front glass plate^{surface} is roughened & it is coated with transparent V_2O_5 volatite with same refractive index as that of glass. Other back glass plates ^{any side} is blackened.

* In between the plates it is filled with liquid.

* The transparent ~~liquid~~ coating acts as an electrodes.

Working

* When no voltage is applied to transparent electrode that is "off" condition the black ground is seen through liquid & front glass plate.

* when voltage is applied to transparent electrode in "ON" condition the applied voltage will heat the transparent electrode causing evaporation of liquid in contact thus it forms combination of vapour film & vapour bubbles around roughened glass.

• The refractive index of vapour^{unity} & liquid are different now which leads to the light scattering. thus LCD cell appears bright.

• The only disadvantage is that its speed of operation is low.

Visual Display Unit (VDU)

* Visual display unit displays are used to display alphanumeric, graphic and pictorial data generated electronically.

* To reduce the number of connections & complexity of drive logic circuitry CRT is used VDU's.

* Data are stored in CRT in form of electronic charge. Characters are generated by line raster technique.

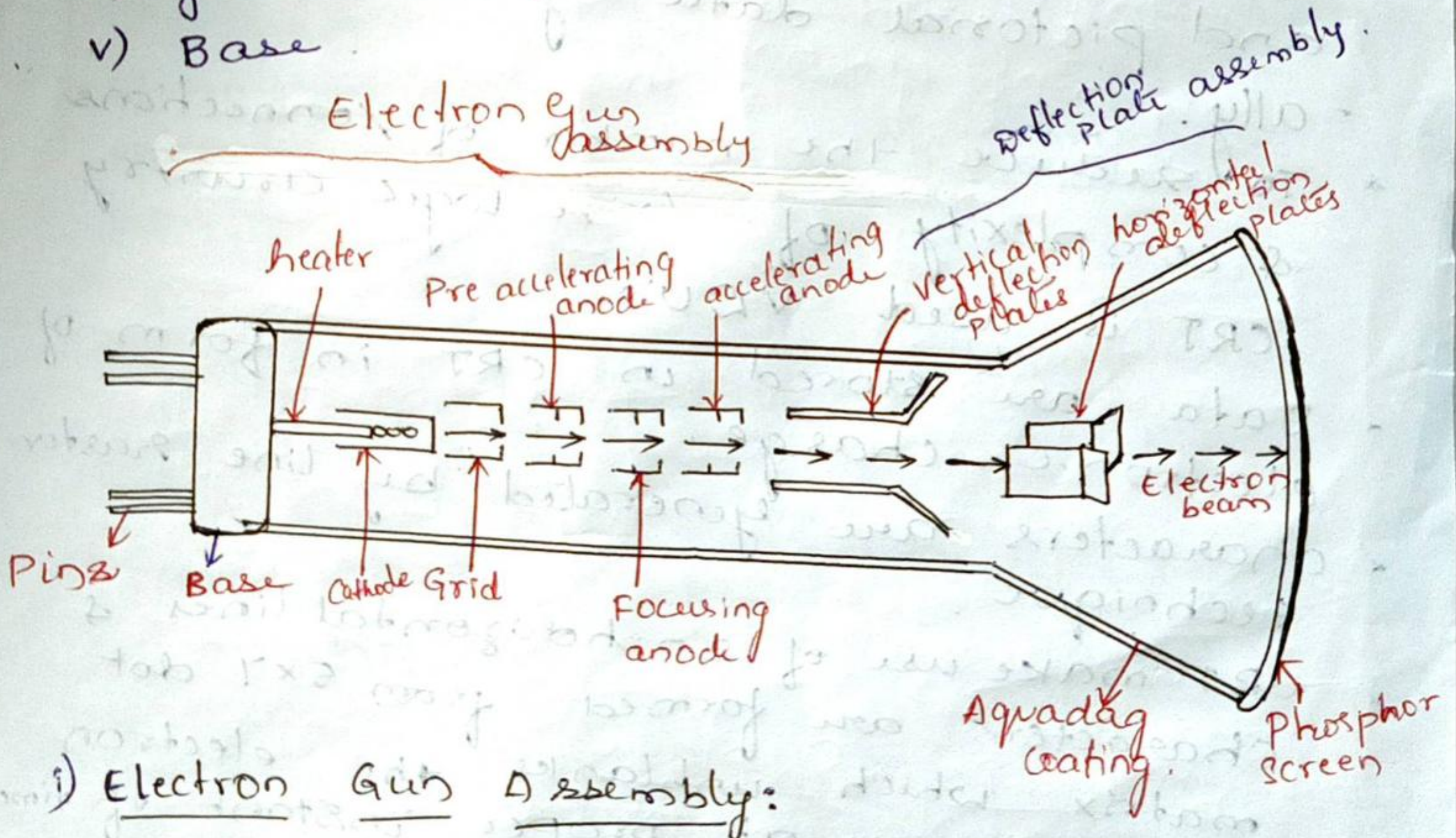
* CRT make use of 20 horizontal lines & characters are formed from 5x7 dot matrix which unblanks the electron beam & sweep at proper instant of time.

* It contains decoder connected to character generator which accepts BCD input & connected to control grid signals which produced desired characters.

- * Versatile storage type VDU which have 39 rows of 85 characters. each have 9×7 dot matrix.
- * Graphic mode have $1024(x)$ by $780(y)$ points on screen to be individually energized.
- * which with increase in CRT for display purposes tubes of $0.3-0.4$ m diameter can display million points of information

CRT :-

- * Cathode Ray Oscilloscope consists of cathode ray tube. The main parts of CRT are
 - Electron gun assembly
 - Deflection plate assembly.
 - Fluorescent screen \rightarrow phosphor screen
 - glass envelope
 - Base



i) Electron Gun Assembly:

- Electron gun emits electrons & its the source for focused & accelerated electron beam.
- it consists of following parts.
 - Base

- a) Base & pins: connections to various electrodes are made through pins in the base.
- b) Heater & cathode: heater heats the cathode. Cathode ends are coated with barium & strontium oxide which to obtain high emission of electrons.
- c) control grid: It is a metal cup usually a nickel cylinder which controls number of electrons. Intensity is controlled by control grid.
- d) Pre-accelerating & accelerating anode: - It is used to accelerate the electrons from grid.
- e) Focusing anode: used to focus the electron beam. usually electrostatic focusing is used in CRT.

ii) Deflection plates

• Electron beam after leaving electron gun it enters two pairs of deflection plates

i) vertical deflection plates @ y plates: these plates are mounted horizontally & produce vertical deflection of beam

ii) horizontal deflection plates @ x plates: they are mounted vertically & produce horizontal deflection of beam

iii) screen for CRT:

• Front of CRT is called face plate it is formed by pressing molten glass & annealing it or by fibre optics.

• Inside surface of face plate is coated with phosphor.

Phosphor converts electrical energy to light energy.

iv) Aquadag:

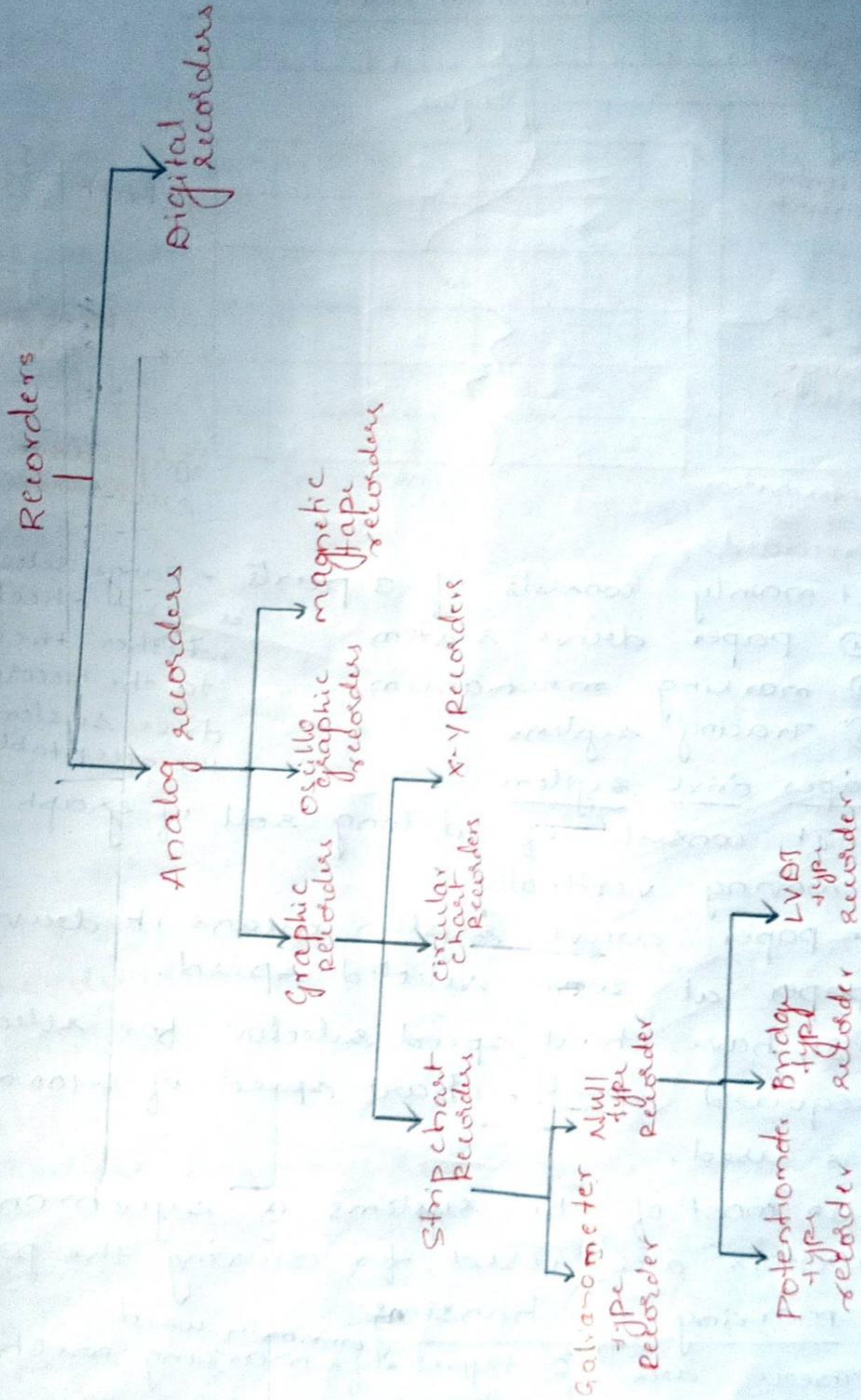
• electrons striking screen release secondary electrons these are collected by aqueous solution of graphite called aquadag.

- It is connected to second anode & it helps in keeping CRT screen in electrical equilibrium state.

working:-

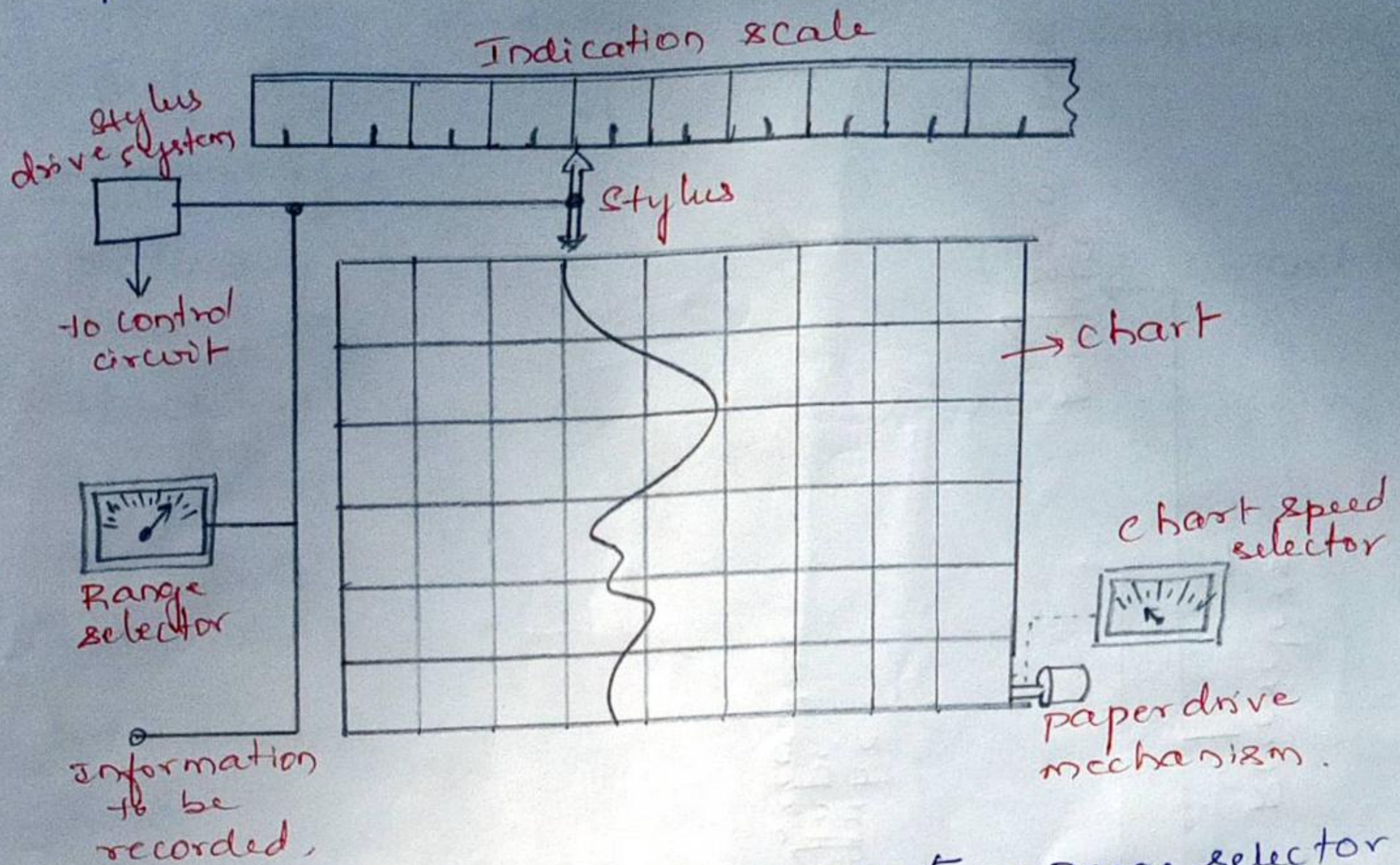
- Electron gun assembly produces a sharply focused beam of electrons which are accelerated at high velocity.
- later beam passes through electrostatic deflection plates. In this the applied voltages ^{to} ~~make~~ the plates makes beam to move vertically up & down or horizontally from one side to another thus beam can be focused anywhere on screen.
- CRT is enclosed in a evacuated glass envelope so that electrons move freely from one end of the tube to other end.

Recorders



STRIP CHART RECORDERS (or) x-t recorder.

It records one or more variables with respect to time



* It mainly consists of 3 parts

- ① paper drive system
- ② marking mechanism
- ③ Tracing systems.

* Range selector is used to check whether the input to the recorder drive system is within the acceptable level.

* i) Paper drive system:

- It consists of a long roll of graph paper moving vertically
- paper drive system means it drives the paper at some selected speed.
- It has a chart speed selector for selecting required speed. Chart speed of 1-100 mm/s is used.
- In most of the systems a synchronous motor is used for driving the paper.

ii) marking mechanism:

There are 6 types of marking mechanisms commonly used they are.

① marking with ink filled stylus

- Stylus is filled with ink using capillary action
- There will be a capillary connection between

pen & pen reservoir.

- usually red colour ^{ink} are used for displays.
- In this stylus is moves over a pre-printed graph paper & traces the variations of input signal.

Advantages

- ① ordinary paper can be used so its cost is low
- ② it can be operated over wide range of recording speeds.

disadvantages

- ① ink splatters when stylus moves at high speed
 batches at low speed & ink clogs at rest
- ② frequency limit only a few Hz.

② Marking with treated stylus

- In this method stylus is treated & it made to move on special type of paper which will ^{thus} record the output.
- ie white wax is melted & it is pointed on black paper.
- the disadvantages of ink filled stylus is overcome in this method.

Advantages

- This method is reliable & gives high contrast traces
- ~~It has~~ frequency response upto 40 Hz.

disadvantages

- 1) since special paper, special pens & wax coating surface need to be printed its cost is high
- 2) it cant record certain processes like which produce heat because it indirectly affect recording.

3. Chopper bar:

In this method a v shaped pointer is passed under a chopper thus it presses the pen into the paper once according to selected interval, thus it makes marks on paper.

Advantages

1. It has straight line horizontal scale is present instead of complex linkage arrangement.

disadvantages

1. This system is not continuous thus not suitable for fast varying quantities.

4. Electric stylus marking

- In this method have paper which have special coating & it is sensitive to current
- In this when current is conducted from stylus to paper a trace appears on paper.

advantages

- ① It has wide marking speeds
- ② low stylus friction
- ③ long stylus life

disadvantages

- ① cost of paper is high.

⑤ Electrostatic stylus

- In this method electro sensitive paper is used & a stylus which produces high voltage discharge is used & it produces permanent trace on paper.

- It is employed in recorders having

chart size: 50mm wide

voltage range: 10mV/mm to 5V/mm

speed : 300mm/s to 10mm/min

frequency response: 60 Hz
amplitude of 1 db.

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⑥ Optical marking method

In this method a high beam of light is made to write on photosensitive paper.

Advantages

- ① allows high frequencies to be recorded
- ② it has large chart speed
- ③ good resolution

disadvantages

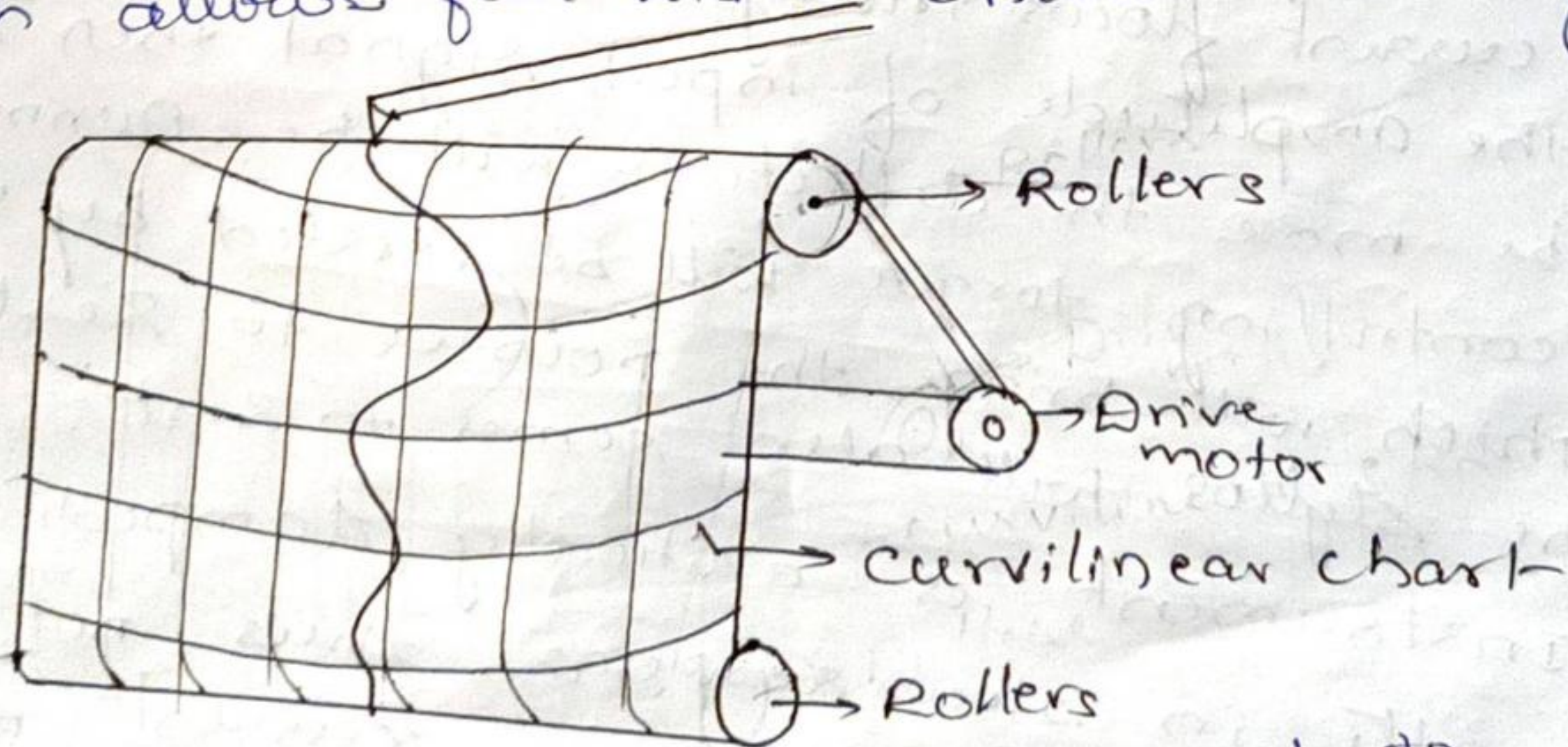
- ① paper cost is very high.
- ② paper should be developed before the operation so ^{this method is} not suitable for process where instantaneous monitoring is done.

iii) Tracing system:

They have two systems.

① curvilinear system:

In this system stylus is mounted on a central pivot & moves through an arc which allows full width chart marking.

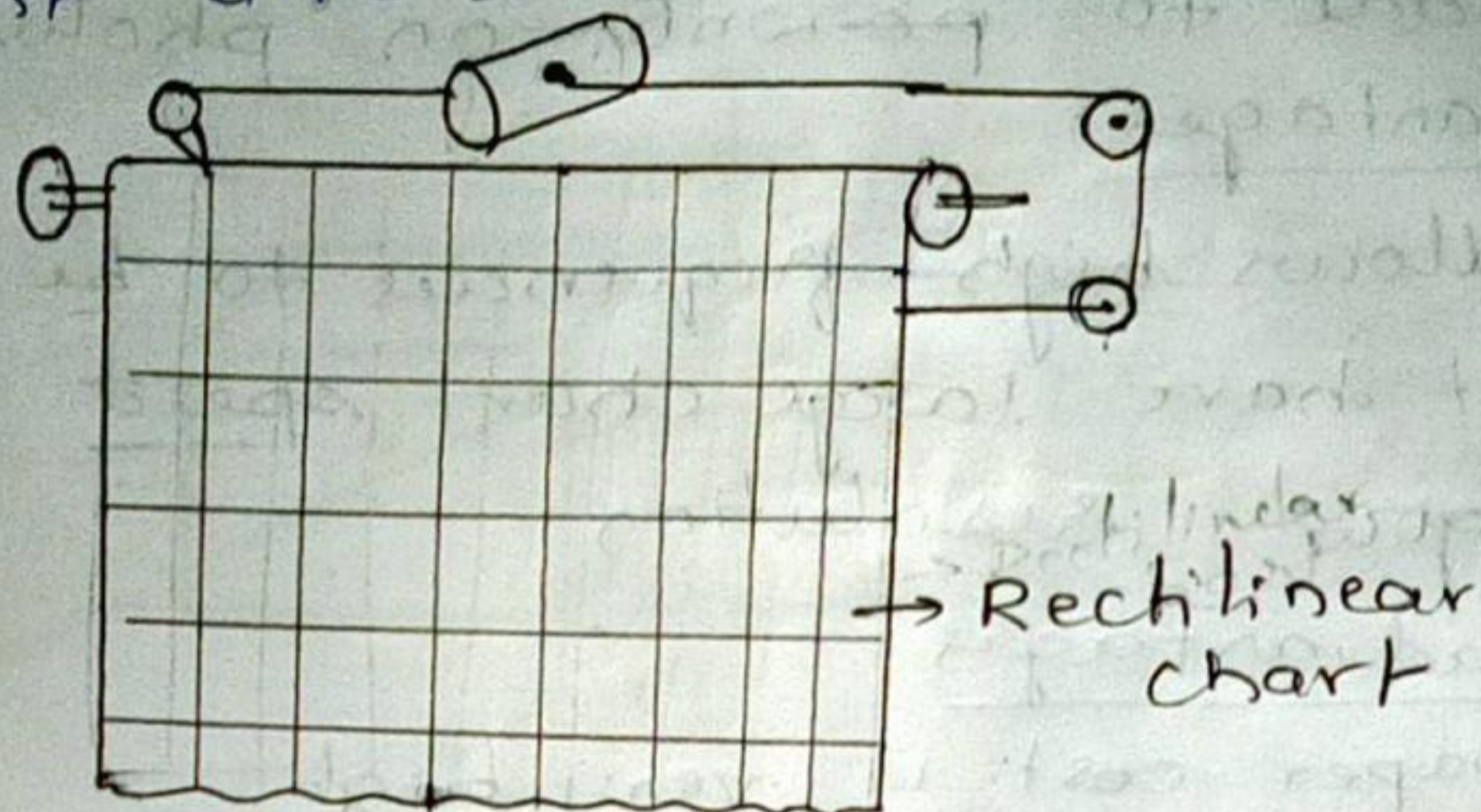


• main disadvantage is difficult to analyse as it has curved time base lines

② Rectilinear system:

* In this stylus is actuated by drive cord over pulley which produces forward & reverse motion by drive mechanism.

- * This method is used for thermal or electric writing.
- In this the line of constant time is perpendicular to time axis thus produces straight line across width of chart.



TYPES of strip chart recorders.

1. Galvanometer type
2. Null type.

1. Galvanometer type recorders.

Principle:- it works on the principle of D'Arsonval movement.

"The galvanometer produces deflection when current flows through its coils. as greater the amplitude of input signal then there will be more the deflection will be. During this controlling torque will be exerted by spring which will bring the pointer to rest thus the stylus will also come to rest."

- * Instrument is critically damped which results in slow response, thus not used for fast variations in current or voltage or power.

Construction:

- * It consists of a moving coil which is kept in a strong magnetic field.
- * It also consists of pen-ink system which have recording pen at one end &

ink reservoir at another end both are connected with bore tube. (13)

- * Due to gravity & capillary actions ink flows from reservoir to pen.
- * This pen ink system is fitted to the pointer used for recording the signal.
- * Paper is pulled by roll by mechanism which is driven by electric motor.
- * Here we are using the curvilinear system of tracing.

Operation

- * As the input signal is given its corresponding current flows through the coil thus magnetic field density changes.
- * Change in magnetic field interacts with magnetic field of permanent magnet which causes for the angular deflection of moving coil.
- * As coil moves correspondingly pen will be deflected across paper thus input is recorded.

- * During the operation of galvanometer will be subjected to sliding friction also called Coulomb friction.
- * It is given by eqn of motion of galvanometer

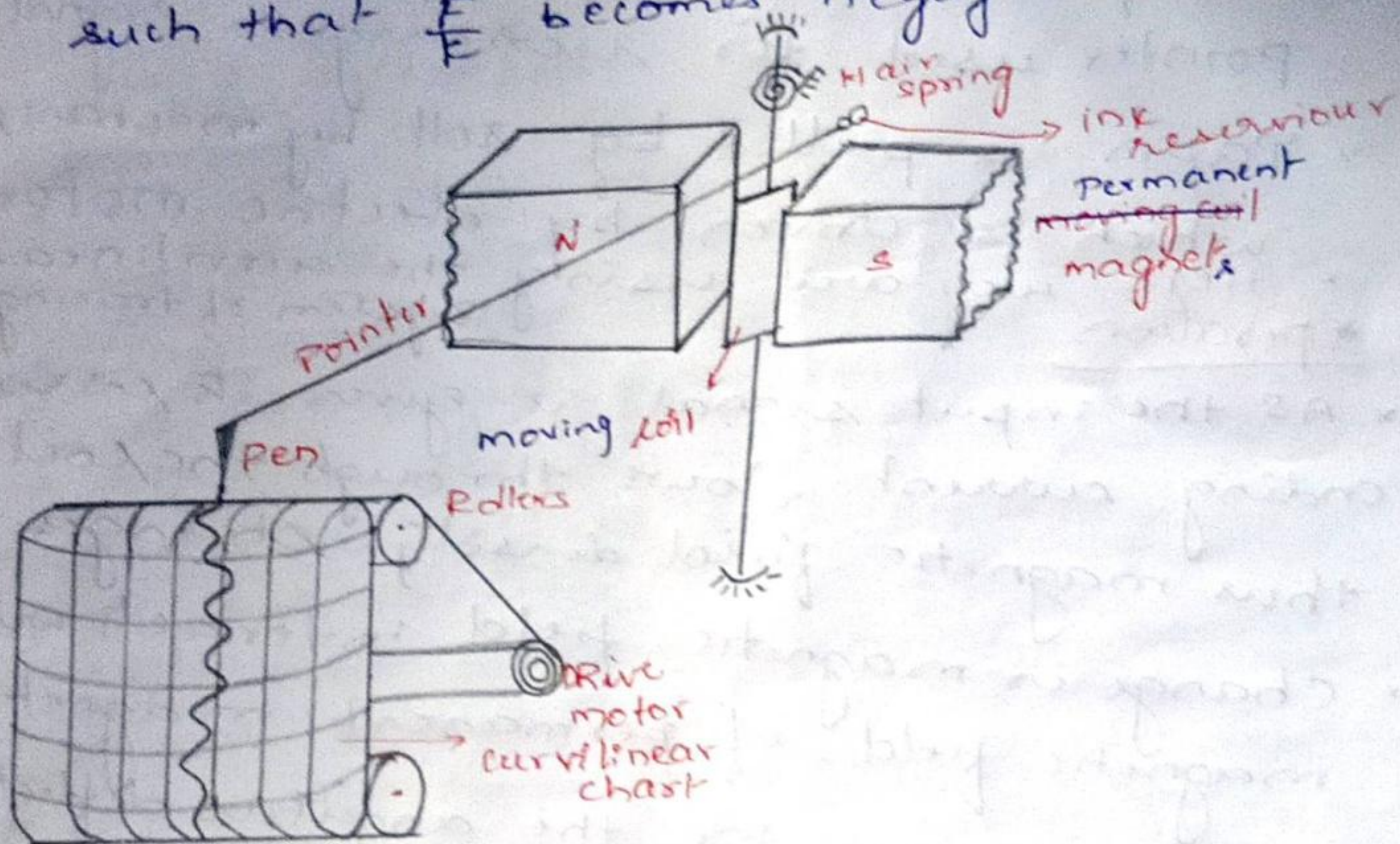
$$J \frac{d^2\theta}{dt^2} + D \cdot \frac{d\theta}{dt} + K\theta + F = Gi$$

where J = constant of inertia
 D = damping constant
 F = Coulomb friction torque N-m
 K = restoration constant & G = displacement constant of gal

at steady state.

$$K\theta + F = Gi \quad \text{or} \quad \theta = \frac{Gi - F}{K}$$

the deflection of stylus of galvanometer is proportional to the product of $\frac{G}{R}$ & i .
 it is clear that driving torque should be reduced to minimum possible made large & coulomb friction should be minimum such that $\frac{F}{E}$ becomes negligible.



Advantages

1. System is comparatively inexpensive
2. can record even very low frequency a.c signal.
3. It offers multiple channel operation.
4. we can change speed of paper according to our requirements.

disadvantages

1. slow response
2. Not suitable for fast variations in input signal
3. low input impedance
4. limited sensitivity.
5. unavoidable frictional losses

Null balance recorders

(14)

- * "This recorder works on the principle of self balancing or Null conditions".
- * when the input signal from transducers or sensors is applied to recorder it will disturb the balance of measuring circuit of recorder.
- * because transducer or sensor will convert a non-electrical quantities to equivalent electric quantities.
- * There will be unbalance this will result in producing error signal.
- * This error signal will operate some device which restores balance or bring system to Null conditions.
- * The magnitude of error signal is indicated by amount of movement of restoring device
- * direction of movement of restoring device is indicating direction of measuring quantity being deviated from normal.
- * The transducer output may be voltage (a.c. or d.c) a current (a.c or d.c) or resistance inductance or capacitance.
- * There are 3 types of Null type recorders

① Potentiometric recorder

② Bridge recorder

③ LVDT recorders.

i] Potentiometric or self balancing potentiometric recorder

- * mainly potentiometric recorders are used to overcome the disadvantages of galvanometer type i.e. high input impedance & limited sensitivity.

* It is done by using an amplifier between input terminals and display. but doing so will result in low accuracy.

* so accuracy is improved by comparing input signal with reference voltage by using potentiometer.

operation:

* resulting difference in signal (voltage) is the error signal.

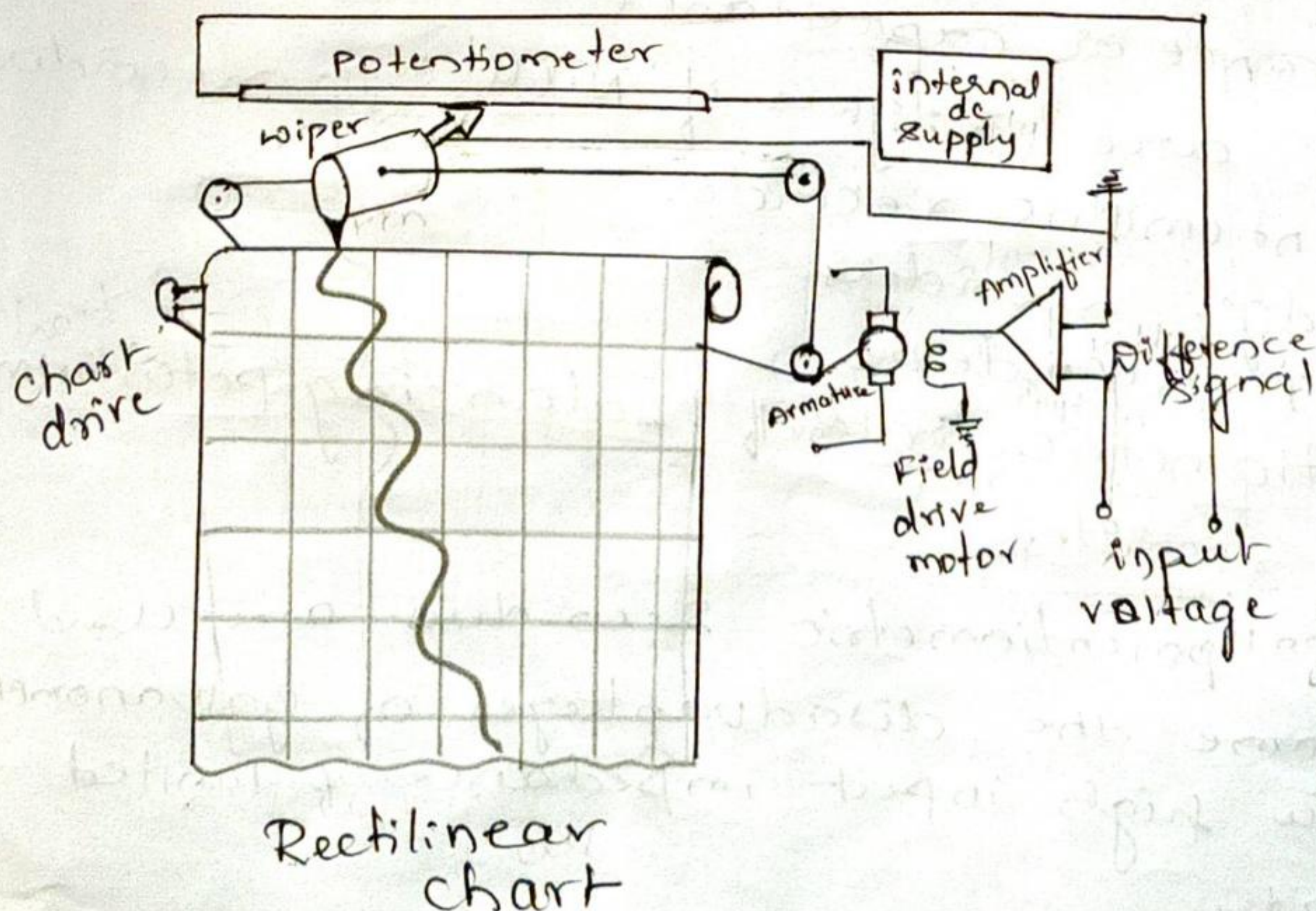
* This error signal is amplified & it is used to energize field coil of d.c motor.

* wiper is connected mechanically to the armature of the motor & it moves over the potentiometer in appropriate direction such that to reduce magnitude of error signal & thus balance is obtained.

* wiper will come to rest when input signal is balanced against reference voltage.

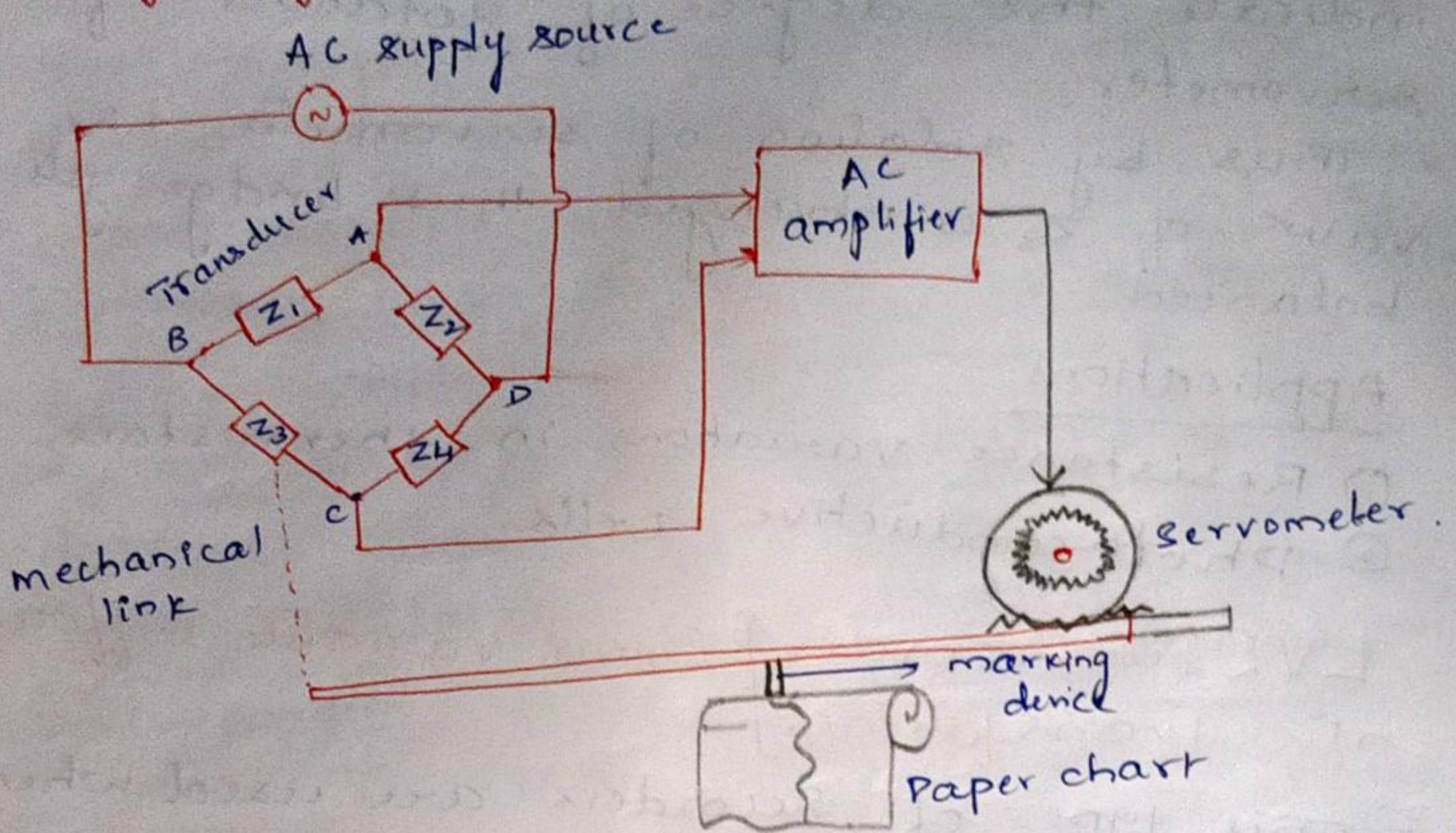
* Pen is coupled with wiper as wiper moves pen also moves in same direction. & thus records variations on paper.

* usually use to control & record the temperature



2) Bridge type Recorder

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- * Above fig shows the block diagram of bridge type recorder.
- * One arm of AC bridge is provided with variable impedance (Z_3) or Resistance & capacitance or inductance. it is as per requirement.
- * & this Z_3 is mechanically coupled with servomotor.
- * Impedance Z_3 varies as the servomotor rotates because they are coupled mechanically.
- * Other arm of ac bridge is provided with transducer Z_1 in which R, L or C varies with variation in input signal.
- * Thus ac bridge gets unbalanced & voltage appears across point A & C which will be given to servomotor through amplifier.
- * This unbalance voltage makes servomotor to rotate & thus it changes the value of Z_3 by which the bridge gets balanced again.
- * when bridge gets balanced no voltage appears across A & C thus servomotor stops rotating.

Degree value of change is Z_1 value will indicate the degree of rotation of servometer.

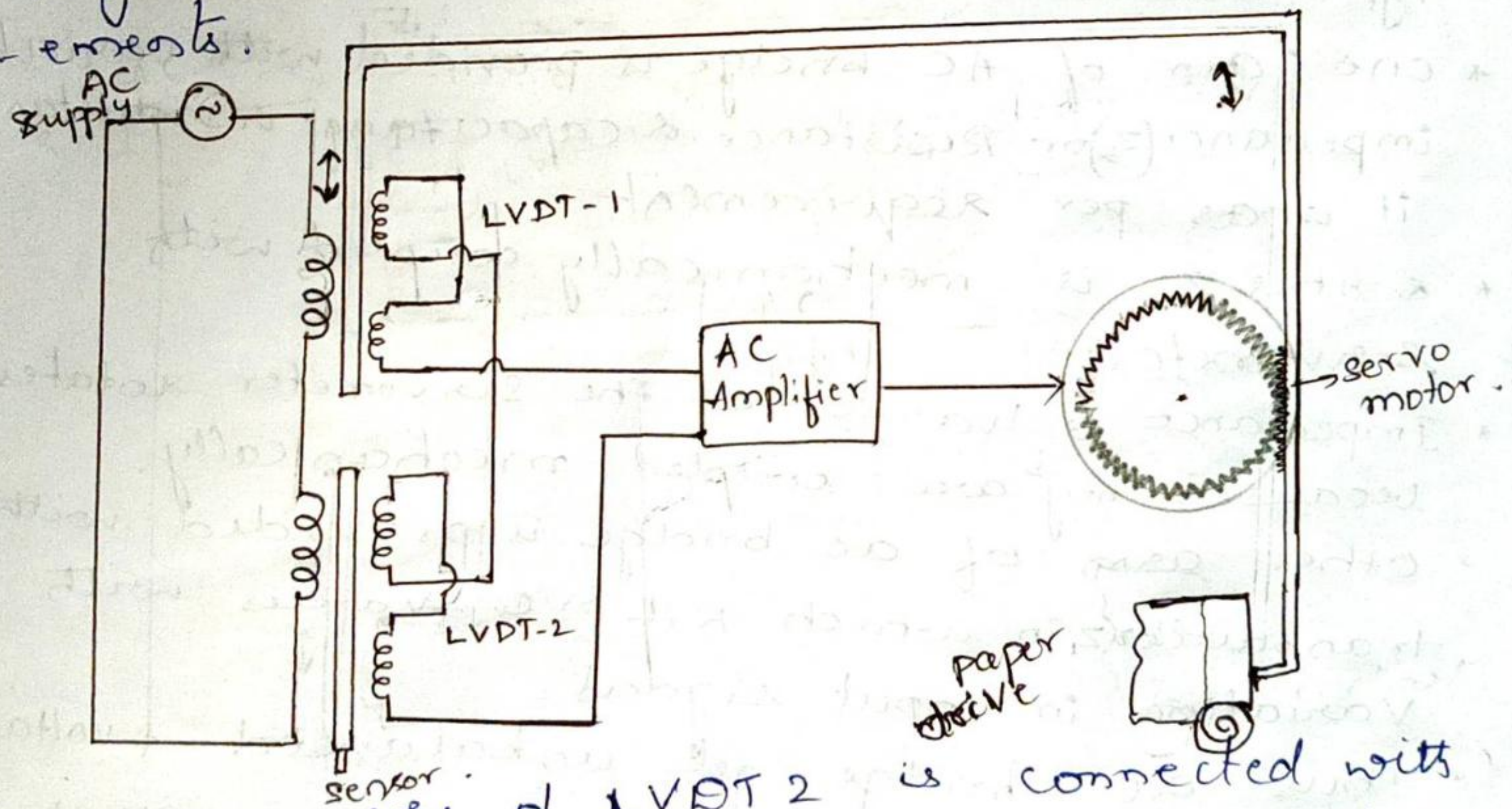
* Thus by rotation of servometer the value of Z_3 is changed thus bridge gets balanced.

Applications

- ① Resistance variations in thermistors.
- ② Photoconductive cells.

LVDT Recorder [Linear variable Differential transformer + transformer]

* This type of recorders are used when signals to be recorded with small displacements.



* moving core of LVDT 2 is connected with sensor in which mechanical movement is recorded.

* moving core of LVDT 1 is mechanically connected with shaft of servometer

* Here LVDT's are connected in series opposition operation

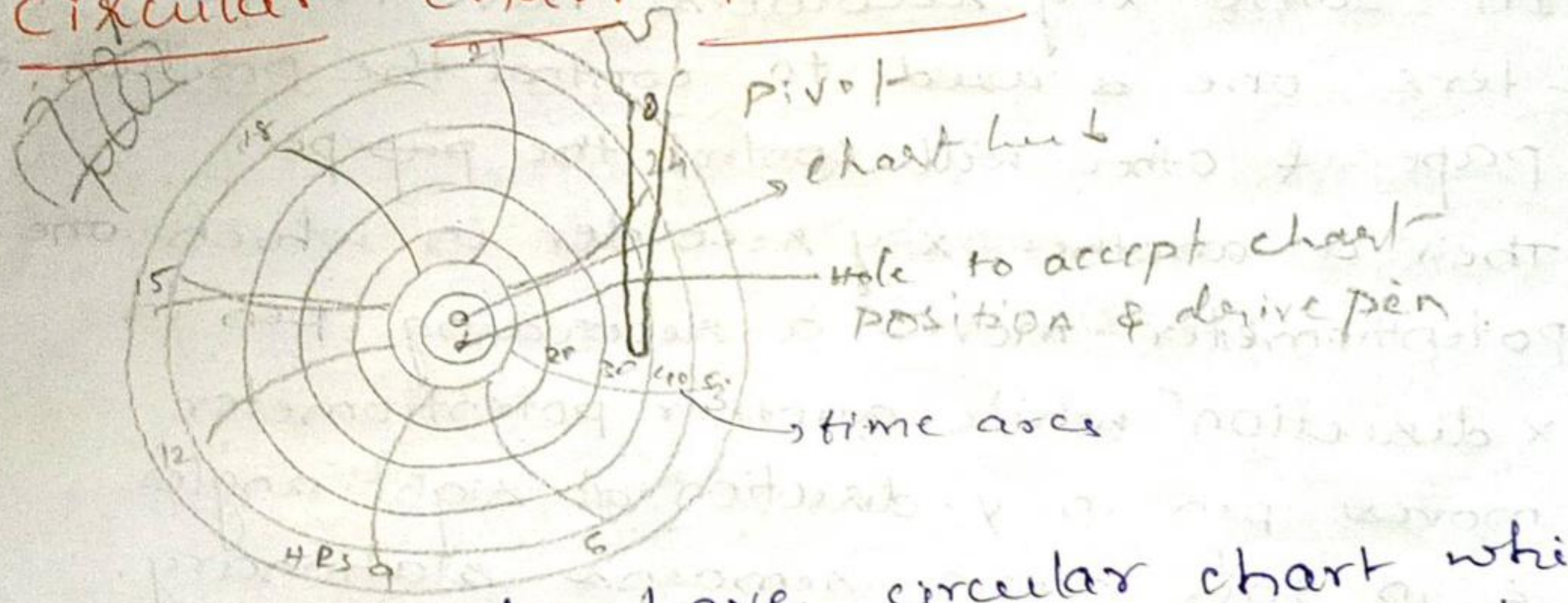
* when core of LVDT 2 moves it causes the output voltage of LVDT 2 to be other than LVDT 1 & thus difference of both these

Voltages is the error signal which is fed as the input to the amplifier.

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- * Thus amplifier amplifies the voltage & supplies to servomotor.
- * Thus servomotor rotates in amount of rotation depends upon the ^{error} output voltage & also while moving it moves the core of the LVDT 1 so that output of LVDT 1 becomes equal to LVDT 2.
- * After balancing the input to the servomotor is zero thus servomotor comes to rest.

Circular chart Recorders



- * These recorders have circular chart which has concentric circles ruled on it to form its scales.
- * In addition they have printed arcs extending from centre of chart to edge of paper. as pen is moved it moves along the arcs.
- * speed of rotation of chart is usually one revolution per 24 hours. or per seven days obtained by synchronous motor with gear assembly.
- * Several variables can be recorded on single chart which is easy to analyze
- * diameter is

disadvantages

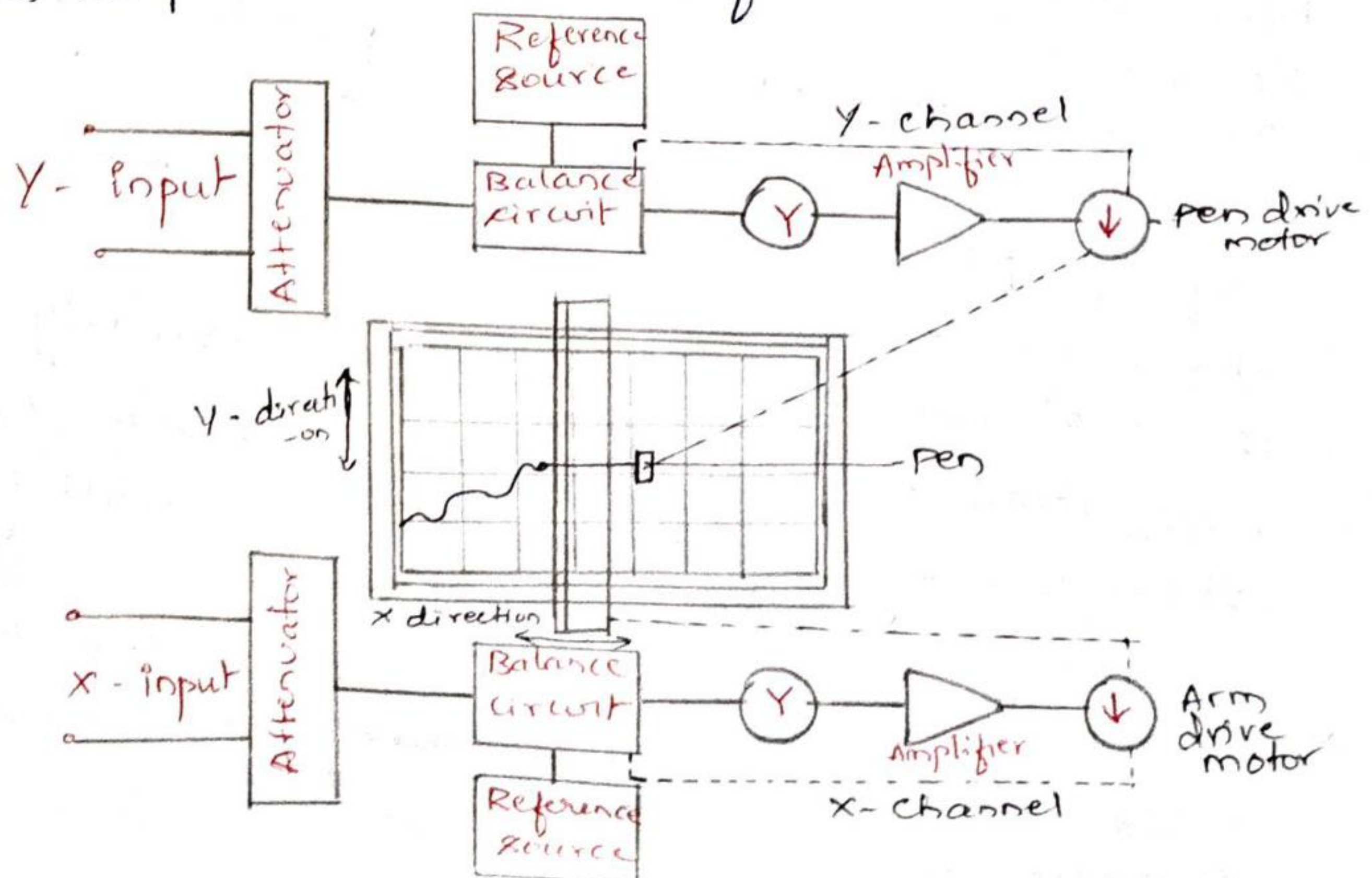
1. Diameter is limited to maximum of 0.3m
2. Speed of chart is limited
3. Resolution is non-uniform.
4. charts do not run for long period.

Application

• suitable for direct actuation by a number of mechanical sensors like bellows, bourdon tubes etc

X-Y Recorders.

- * It is one of the graphic recorder which records the graphic record in relation ship between two variables
- * In some x-y recorders have two potentiometers one is used to control the position of paper & other will control the pen.
- * There is another x-y recorder in which one potentiometer moves a recording pen in x direction while another potentiometer moves pen in y-direction at right angles & in this paper remains stationary.
- * In x-y recorders the Emf will be plotted with respect to another Emf.



- * It consists of two servometer which is used to drive a pen in two axis over a stationary paper. (17)
- * A signal enters the attenuators in this the signals are attenuated to interest full scale range then it passed to balance circuit.
- * In Balance circuit it is compared with reference voltage & error signal is calculated.
- * This error signal is fed to chopper which converts d.c signal to a.c signal.
- * From chopper it is fed to amplifier in which the signal is amplified. This amplified signal will actuate a servometer.
- * The movement of servometer will balance the system thus the values are also recorded.
- * The action takes place in both axis simultaneously, so we get recording of one variable with respect to other.

Applications

1. speed torque characteristics of motors.
2. Plotting characteristics of vacuum tubes, Zener diodes.
3. Regulation curves of power supplies.
4. stress - strain curves, hysteresis curves
5. Resistance versus temperature

Advantages

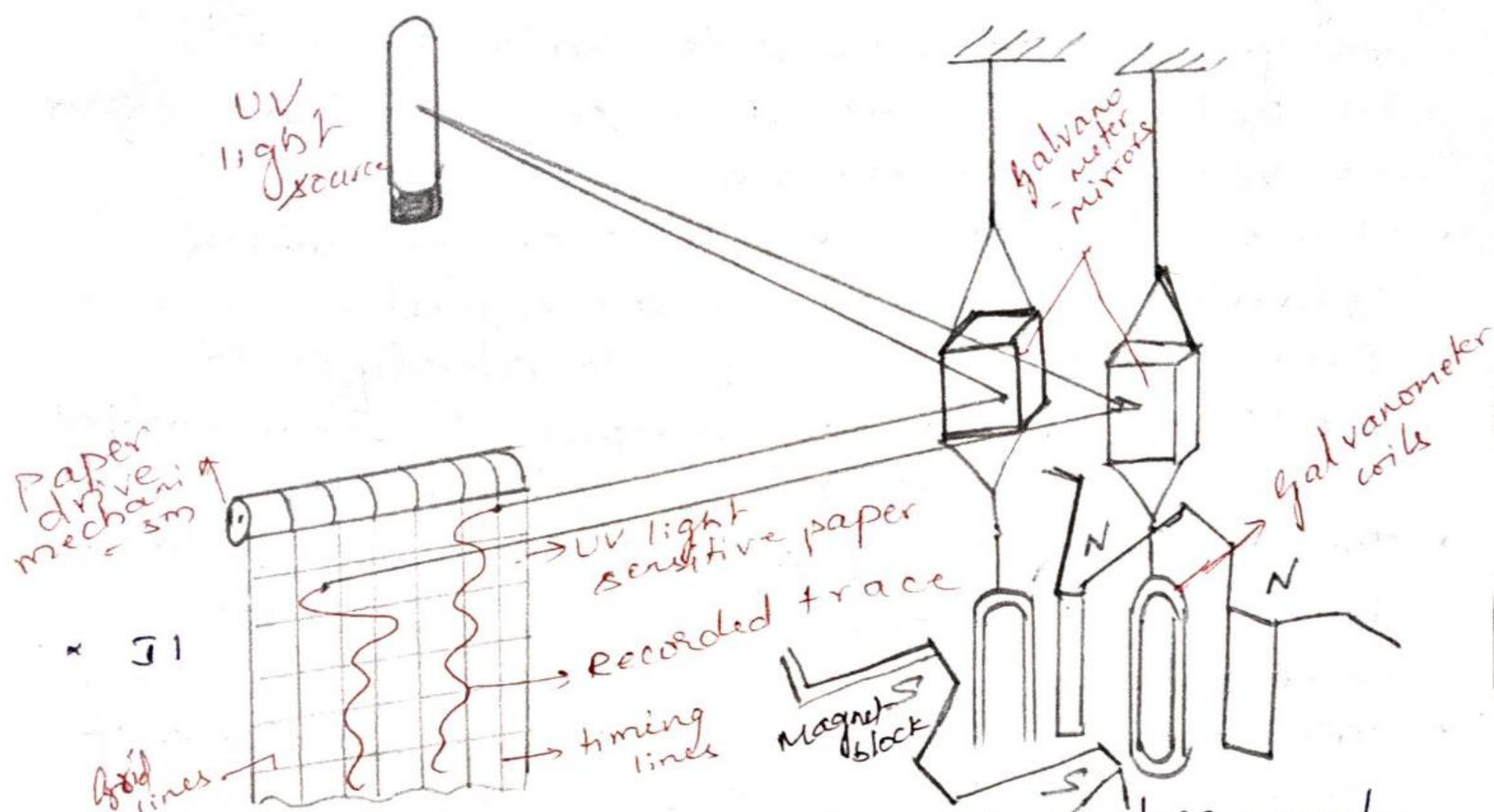
1. Economical as low cost paper is used
2. Easy & convenient to use.

disadvantages

1. cannot be employed for continuous recording
2. due to Electromechanical mechanism speed & frequency response is limited.

U-V Recorders.

- * These are basically Electromechanical Oscillographic type recorders



- * It consists of a number of galvanometer moving coils mounted on single magnet block.
- * galvanometer uses UV light as a source for projection
- * U.V light is projected on paper with the help of mirrors attached to moving coils.
- * Paper used for tracing is U.V sensitive paper (paper is sensitive to U.V light).
- * Paper used consists of
 - ① Grid lines:- These are the lines along the length of the paper. these are obtained by shining the U.V light on paper.
 - ② Timing lines:- These are the lines along the length width of the paper. obtained from vapour tube actuated from external source.

3. Trace identification:

- * u.v recorders are multichannel recorder & records upto 25 channels. (18)
- * each channel may produce 100mm wide peak to peak trace.

operation

- * when a current is passed through the moving coil, it is deflected under the influence of magnetic field of magnet.
- * when uv light falls on the mirror it is deflected & projected on u.v light sensitive paper through lens & mirror.
- * paper is moved & moving light spot thus trace a variation of current with respect to time is produced.
- * Some external arrangement is made for controlling speed of paper
- * For recording the ^{paper} record for long period it is photodeveloped, permanized or photocopied.

Applications

- i) control system performance
- ii) Regulation transients of generator
- iii) output of transducers

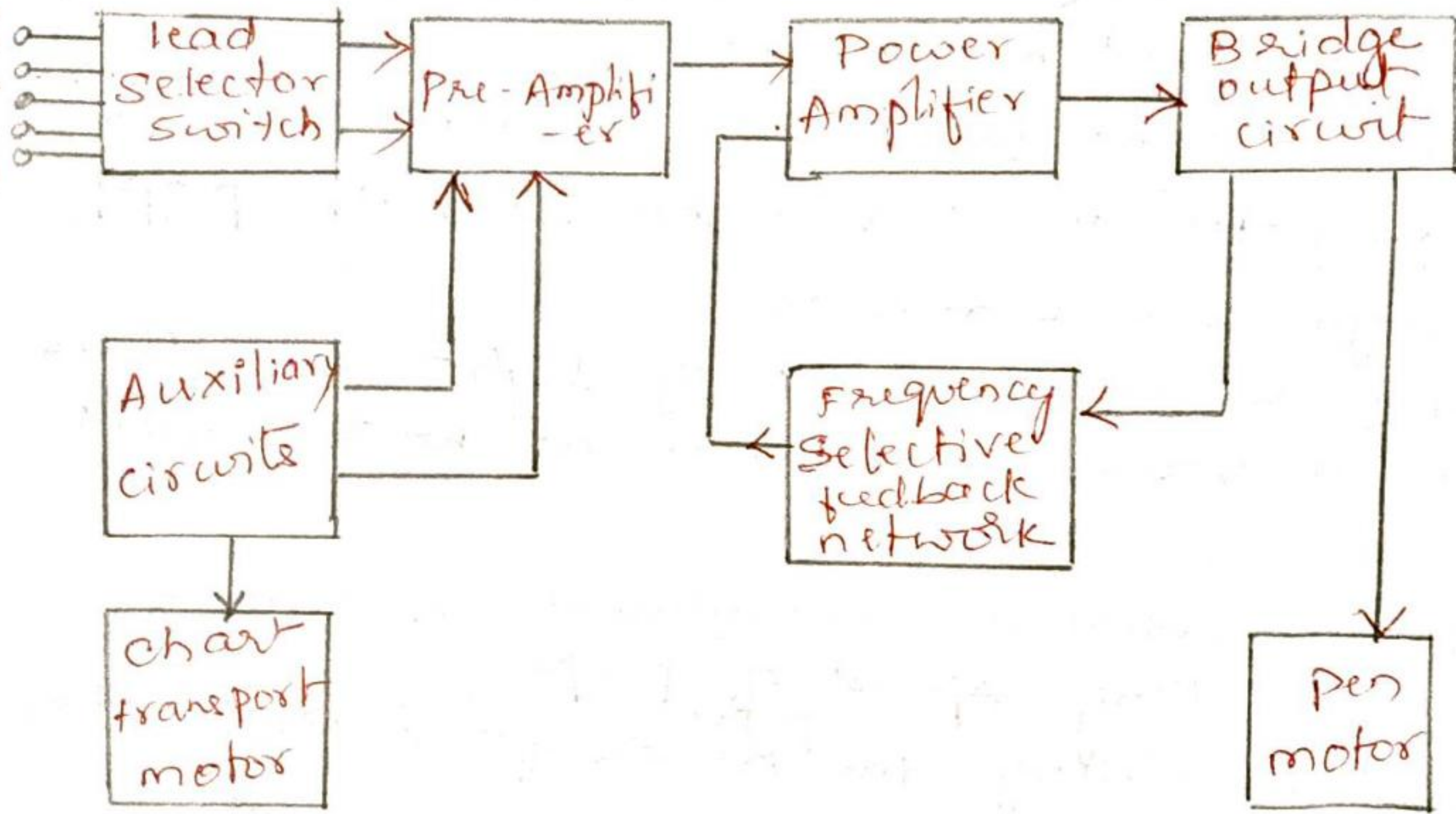
advantages

1. used for both a.c & d.c, upto frequency 400 to 500 Hz.
2. High frequency inputs can be recorded with high ^{paper} speed of 10m/s

ECG:- Electro Cardio Graph.

- * It is an instrument which records the electrical activity of heart.
- * ECG provides information about
 - ① cardiac disorders ie i) presence of inactive ^{Part}
 - ② ii) enlargement of heart muscle.

ECG Electrodes

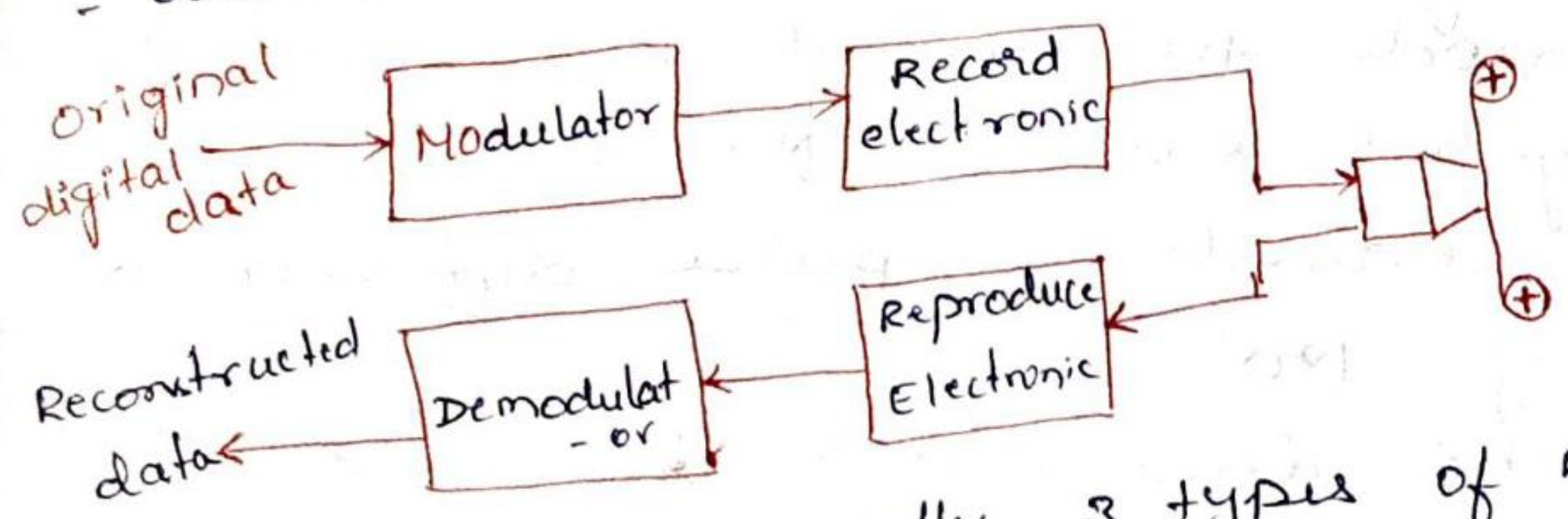


- * Above figure shows the block diagram of ECG.
- * Potential are given as input to lead selector switch through electrodes.
- In lead selector two by two electrodes are selected according to lead program.
- By capacitive coupling output from selector is given to differential preamplifier.
- Differential preamplifier is a 3 to 4 stage amplifier which have large negative current feedback & gives stabilizing effect at last stage.
- From that single ended output ^{from preamplifier} is given as input to power amplifier (push pull type).
- Another input to power amplifier is the feedback signal ^{from} pen position through frequency selective network.

- Output of power amplifier is fed to Pen motor which deflects the pen on paper.
- Frequency selective network is R-C network used to provide necessary damping to pen motor.
- Auxiliary circuit is used for automatic blocking of amplifier during change of position of lead selector switch.
- It also includes speed control circuit for driving the chart.
- * In ECG there is a standby mode in this mode stylus moves in response to input signal & paper remains stationary.
- Output from ECG are recorded on graph paper with horizontal & vertical lines at 1mm interval. usual speed maintained is 25mm/s

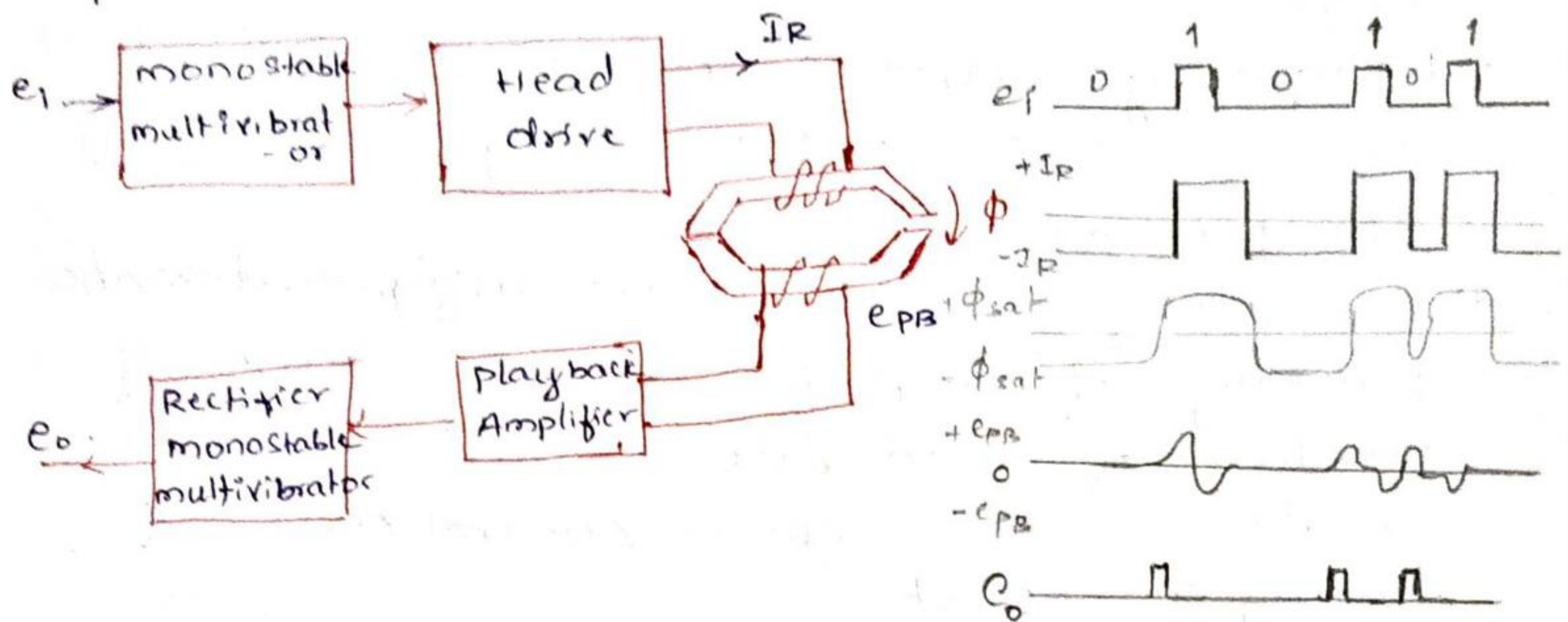
Digital Tape Recorder

- * In this method original data which has to be recorded is modulated first in some form then this modulated data is recorded in magnetic tape.
- * The recorded data is amplified & demodulated & then it is reconstructed

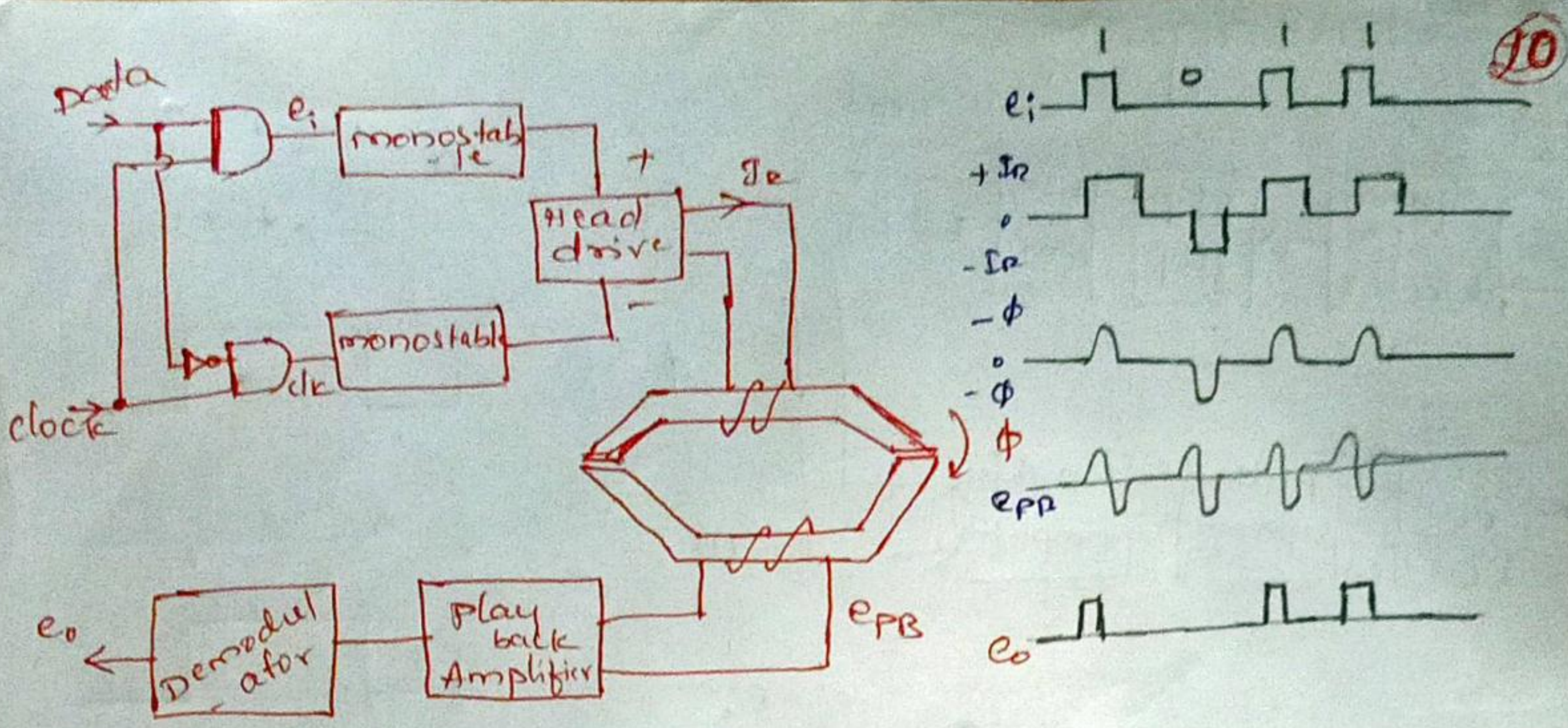


- * There are basically 3 types of digital tape recording
 - ① RB - Return to Bias recording
 - ② RZ - Return to Zero
 - ③ NRZ - Non - return to zero recording

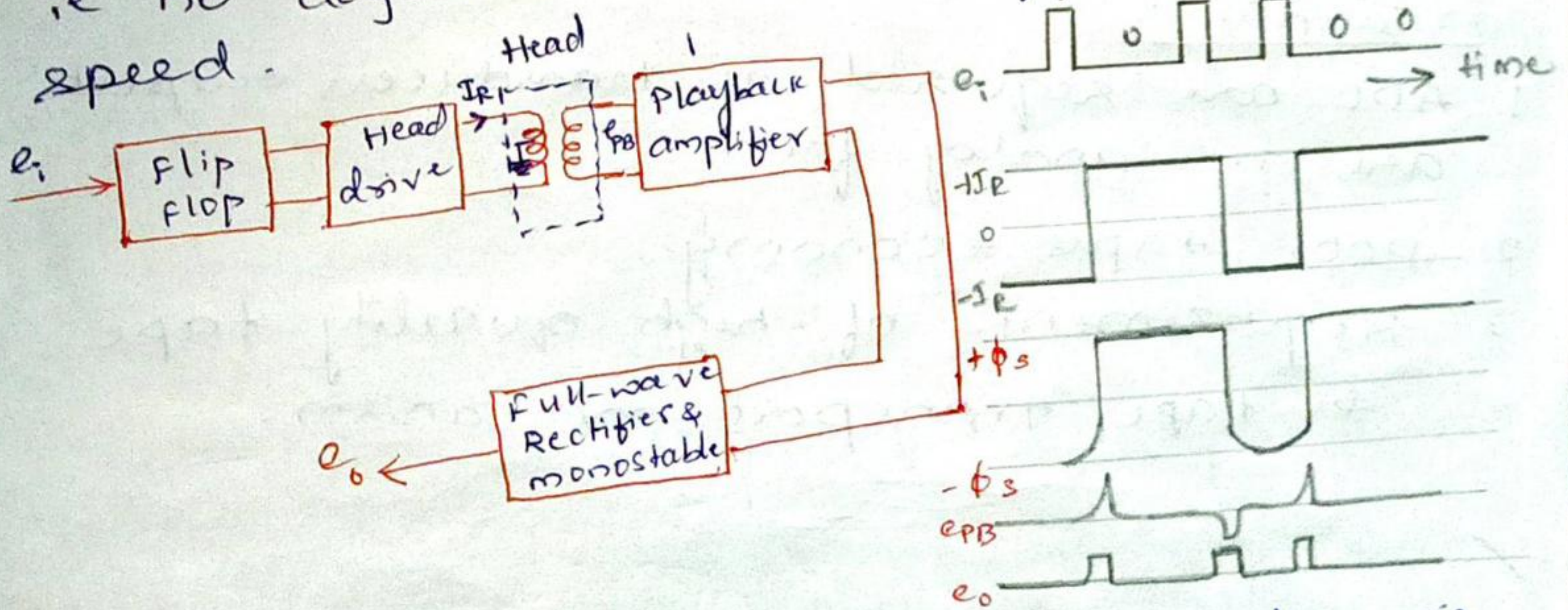
* In RZ recording '1's' in data is representing +ve pulses & '0's' representing absence of pulse shown in below waveforms.



- * Biasing current I_R holds tape at saturation flux level of $-\phi_{sat}$ except till it switches to $+\phi_{sat}$ level.
- * The playback voltage is shown by e_{PB} i.e. playback amplifier rises the voltage level & shortens the rise time.
- * The reconstructed rectified output from monostable rectifier is shown by e_0 in above fig.
- * This method donot have self clocking capability so another method called RZ mode is used.
- * In this method both '1' & '0' state provides self clocking.
- * In this mode +ve current is provided for '1' & negative current for '0'.
- * The e_{PB} consists of pulse differing in phase by 180° .
- * Again the demodulator reconstructs the input pulse which was recorded in output.



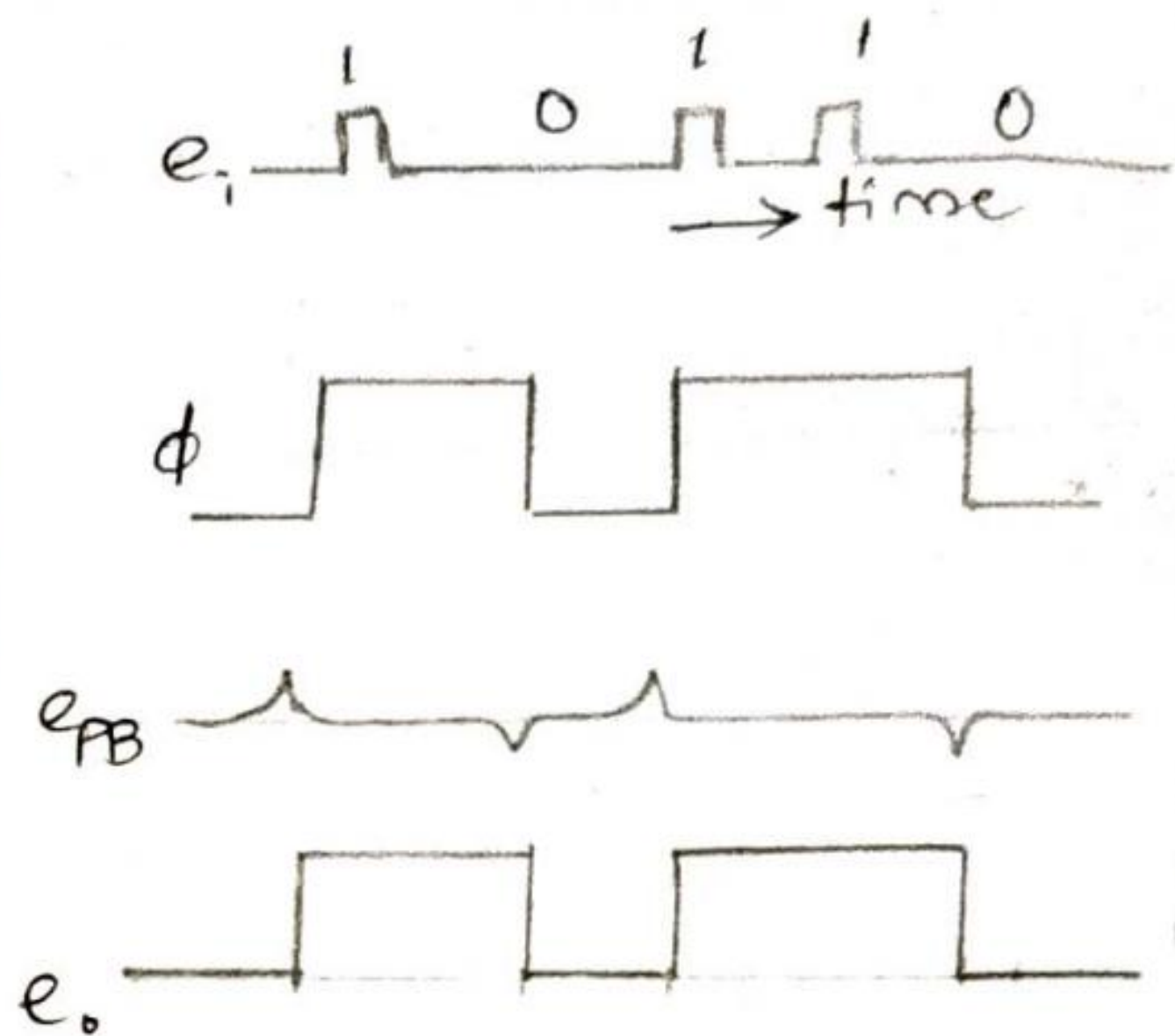
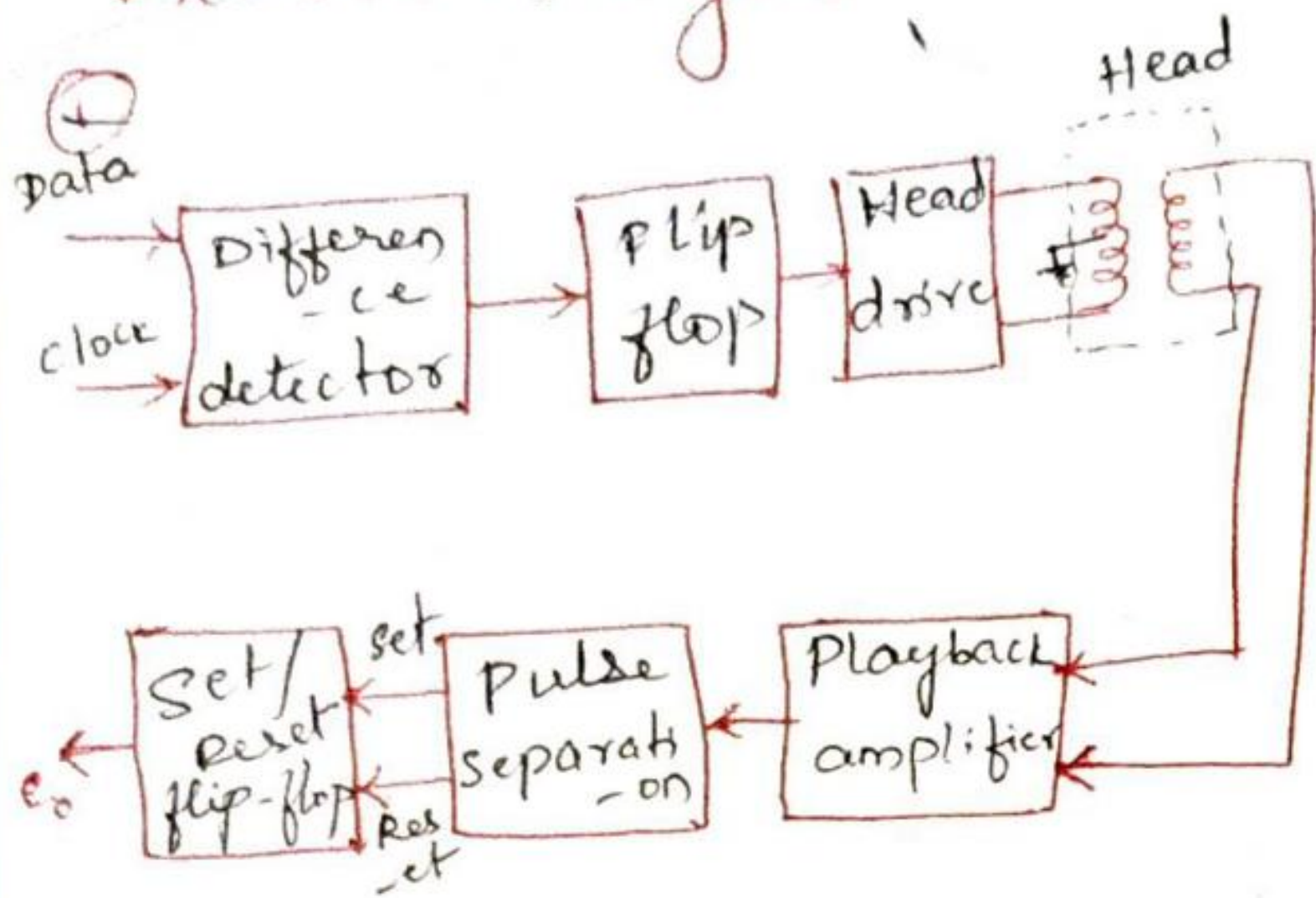
- * There is one more popular method adopted (NRZ-M/NON return zero/mark).
- * In this mode only one flux change per bit so packing density is 320 bits/cm.
- * even this method is not self-clocking so clock track is required to recorded with data.
- * This method is independent of tape velocity ie no adjustments are required at lower speed.



* In NRZ-change (NRZ-C) mode, flux is reversed only when 1 is followed by a 0, or vice versa. A consecutive series of 1s or 0s result in no change.

~~X-Recorder~~

Advantages



Advantages

1. High accuracy
2. Requirement of simple conditioning equipment
3. Insensitivity of tape speed
4. Information can be directly to digital computer for processing & control

drawbacks

1. ADC are required as transducers output are in analog form.
2. Poor tape economy.
3. Requirement of high quality tape & tape transport mechanism.