Electronics

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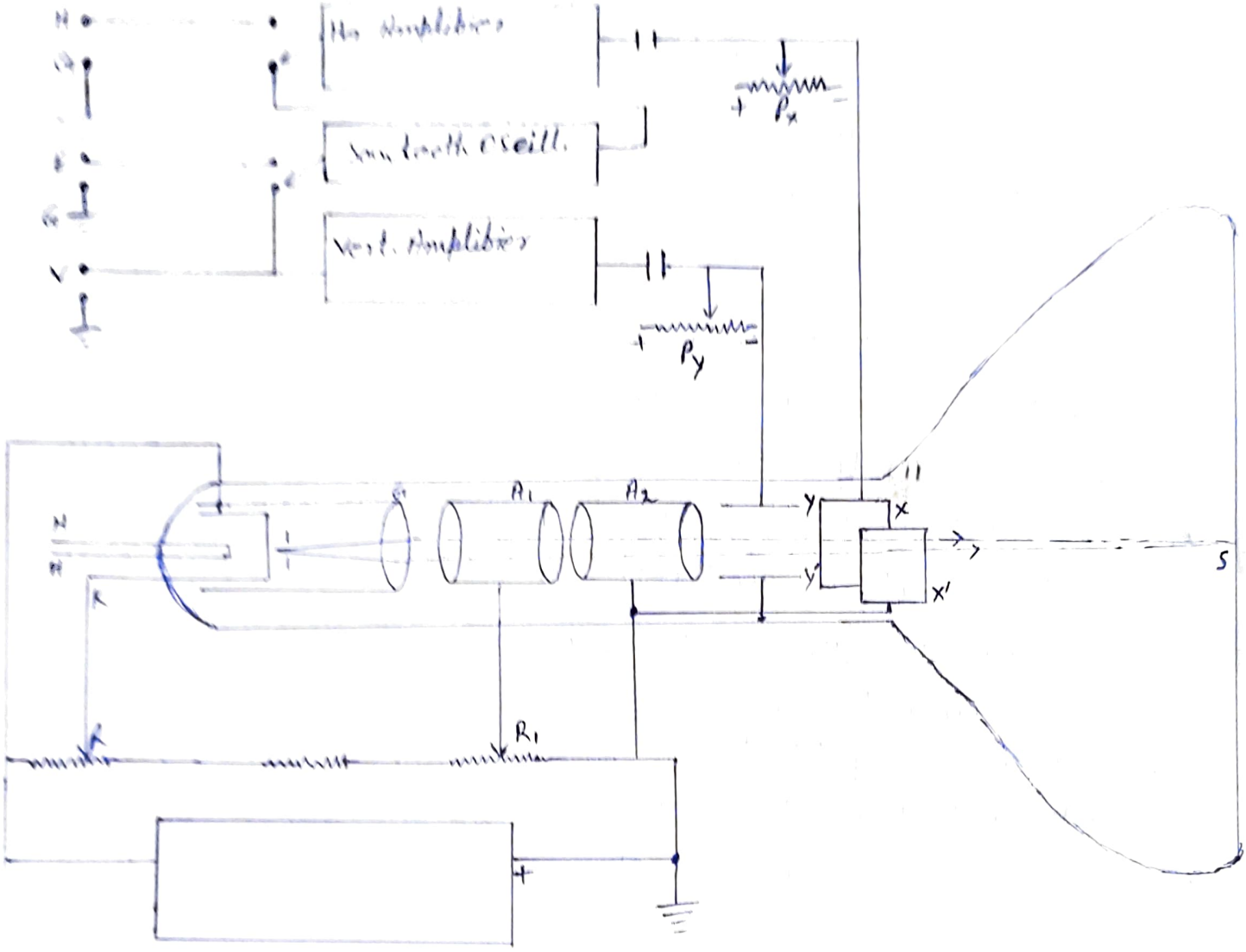
Cathode Ray Oscilloscope (CRO)

Cathode ray oscilloscope is one of the most widely used instrument having large number of applications.



A cathode ray oscilloscope consists of the following main components :-

1) Cathode ray tube
2) Horizontal & vertical voltage amplifiers
3) Power supply circuit.

CONSTRUCTION

1) Cathode, K

It is the form of a cylinder of nickle whose flat surface is coated with oxide of barium and strontium so that a continuous flow of electron is obtained from it when it is indirectly heated to the required temp. (approximately 1050°k) by resistance heating of a tungsten wire H H.

2) Grid, G

It is a nickel cylinder surrounding the cathode K. and it is close to the cathode. It has a small hole in the centre so that a narrow beam of electrons from K can pass through it. It is maintained at a suitable negative voltage called the negative grid bias. The negative grid bias can be changed by means of the potentiometer R. change of grid bias changes the electron beam current and thus the intensity of the spot of light on the screen can be changed.

3) Anodes A_1 and A_2

A_1 and A_2 form a pair of anodes which are nickels cylinders. Each has a narrow hole for the passage of electron beam. A_1 and A_2 are maintained at positive voltages V_1 and V_2 respectively with respect to K, V_2 being greater than V_1. The low voltage of A_1 and higher voltage of A_2 give rise to convex and concave equipotential surfaces in the space.

between A_1 and A_2. There equipotential surfaces form an electric field lews which focusses the beam on the screen.

A_1 is called the focussing anode and A_2 is called the accelerating anode.

The complete assembly of K; G; A_1; A_2 is called the electron gun.

4) Deflection plates XX' and YY'

XX' and YY' are two pairs of Parallel plates perpendicular to each other. They can be connected to external sources of voltages to produce displacement of the electron beam passing through the electric fields between the parallel plates. The plate X' and Y' are connected to the anode A_2 which is connected to the ground terminal.

The whole assembly is enclosed in a glass tube which is evacuated to a pressure of 10^{-6} mm of Mercury.

5) Screen, S :-

The whole of the end inner surface of the glass tube is coated with a suitable fluorescent material.

Example of Materials for coating :-

a) Zinc - orthosilicate :- Green.
b) Calium - tungstate :- Blue.
c) Zinc - Sulphide :- White

Voltage amplifiers for vertical and horizontal Deflection :-

These amplifiers are connected between the input terminals and the deflection plates. The function of the amplifiers is to increase the deflection sensitivity for weak input voltages. The amplifiers are provided with the potentiometers P_x and P_y for horizontal and vertical centering of the spot of light on the screen.

Power supply circuits :-

A low tension voltage for heating the filament HH is obtained across the low tension secondary of the Power transformer of the power supply. The high voltage d.c. power supply provides different required d.c. voltages.

Time base circuits :-

Generally the external voltage which is to be analysed is applied to the vertical y plates. To get the waveform of the applied voltage on the screen a sweep voltage in the horizontal direction should be applied. This is achieved by applying a "time base" voltage to the horizontal X plates. The time base voltage is periodic in nature and increase linearly with time and suddenly falls to zero.

Uses of Cathode Ray Oscilloscope (CRO)

1) Electrical Measurements :-

Both D.C. and A.C. voltages can be measured by this instrument. It has been observed that deflection of the electron beam is directly proportional to the voltage applied to the deflecting plates.

Hence if the direct voltage is to be measured, then it is applied to one pair of deflecting plates and the corresponding deflection of the spot is measured knowing the deflection due to standard voltage., the value of applied D.C. voltage can be obtained.

2) Measurement of Frequency and Phase angle:-

Suppose the electron beam from the electron gun is subjected to the simultaneous simple harmonic A.C. voltages perpendicular to each other.

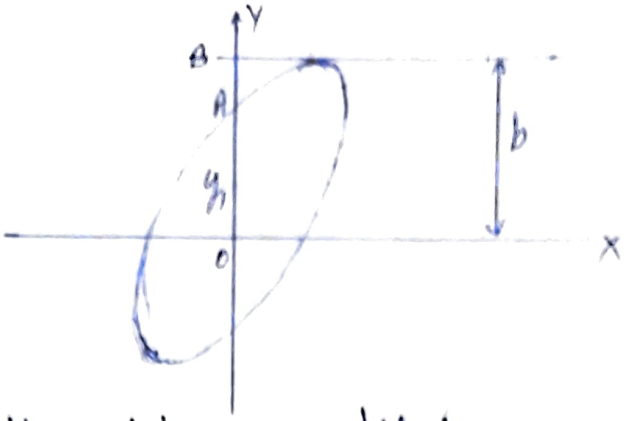
Let the two A.C. voltages be represented by

$$x = a \sin\left(2\pi n_1 t + \phi\right) \quad \ldots\ldots\ldots (1)$$

$$y = b \sin\left(2\pi n_2 t\right) \quad \ldots\ldots\ldots (2)$$

where a and b are the amplitudes of the voltages; n_1 and n_2 are the frequencies and ϕ is the phase difference between the voltages.

Under the action of the simple harmonic A.C. voltages, the electron beam will describe a Lissajous figure.



If $n_1 = n_2$, the figure will be an ellipse.
The equation of the resultant motion is

$$\frac{x^2}{a^2} + \frac{y^2}{b^2} - \frac{2xy}{ab}\cos\phi = \sin^2\phi \quad \ldots\ldots(1).$$

The nature of resultant motion depends on the phase difference ϕ.

we have $\frac{y^2}{b^2} = \sin^2\phi$

$$\sin\phi = \pm\frac{y}{b} \quad \ldots\ldots\ldots\ldots(2)$$

Thus by the observation of Lissajous figure on the screen, unknown frequency of an alternating voltage is determined, and the phase difference between the A.C. voltage is determined by using equn (2).

Other uses of CRO :-

CRO is used in both television receiver and ADAR. It is also used in construction of electrocardiograph. CRO is used to study mechanical pressure. CRO is used to measure extremely short interval of time.