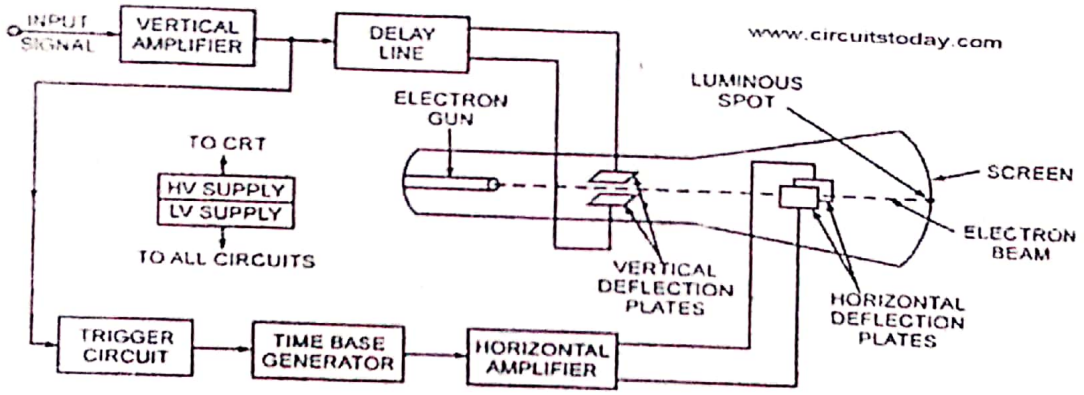
Cathode Ray Oscillograph (CRO):→

CRO is a device used to study waveforms of sound waves, alternating voltages etc. It consists of following main units

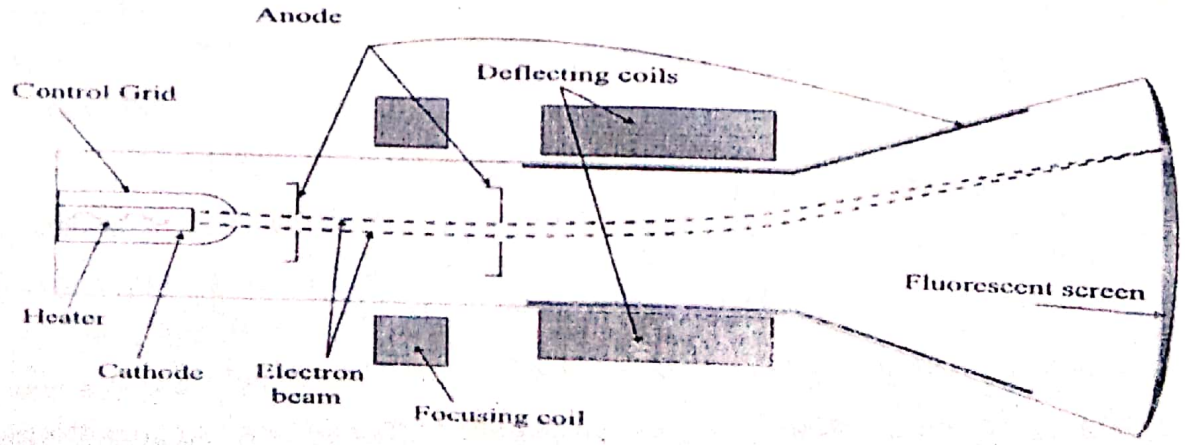
① Cathode ray tube ② Power supply
③ Horizontal & Vertical Amplifiers ④ Time base generator

Out of all these units, heart of a CRO is CRT i.e cathode ray tube.



Block Diagram of a General Purpose CRO

① Cathode ray tube (CRT):→



Principle:— It is based upon the principle that the beam of electrons or cathode rays can be brought to focus on a flourescent screen by suitable electric or mag. field in the same way, as a beam of light is brought to focus on a screen by an optical lens. The process of focussing electron beam by electric or magnetic field is called electrostatic or magnetic focussing respectively. A suitable time base generater is used to deflect the beam of electrons in a direction ⊥ to direction in which cathode rays are deflected by electrostatic or mag. field.

There are three main parts of cathode ray tube:-

(i) Electron gun, which produces the continuous beam of electrons and directs them along a st. line.

(ii) Deflecting system, which deflects the beam of electrons. The deflection may be produced by electrostatic or mag. field.

(iii) Flourescent screen, The beam of electrons is made to focus on the screen in the form of a fine spot of light.

The electron gun consists of an oxide coated cylindrical cathode K, which is indirectly heated by a filament F, which emits electrons due to thermionic emmision. A cylinder G of Nickel surrounds the cathode. It is provided with central hole, which is coaxial with the axis of tube. This cylinder is called control grid. It is kept at -ve potential, so that electrons are repelled by it and thus beam of electrons travel along the centre of opening. The no. of electrons passing through the grid and hence brightness of spot on the screen can be controlled by varying the -ve grid potential. A_1 and A_2 are the cylindrical anodes and are kept at higher +ve potential w.r.t cathode. Potential of A_2 is higher than that of A_1. The two anodes helps to accelerate electrons and bring them to sharp focus at flourescent screen.

The beam of electrons emerging out of electron gun can be deflected vertically or horizontally with the help of electrostatic field. YY and XX are two sets of parallel horizontal and vertical plates along which the field is applied. So as to deflect the electron beam along vertical & horizontal directions.

inner surface of screen s is coated with some flourescent material so that invisible electron beam falling on the screen is converted into visible spot outside due to flourescence.

When an alternating field is applied across y-plates visible spot of light alternately moves towards either of two +vely charged plates and due to persistance of vision a vertical st line is traced out similarly of no field is applied across y-plates and alternating field is applied across x-plates a horizontal line is traced out on flourescent screen.

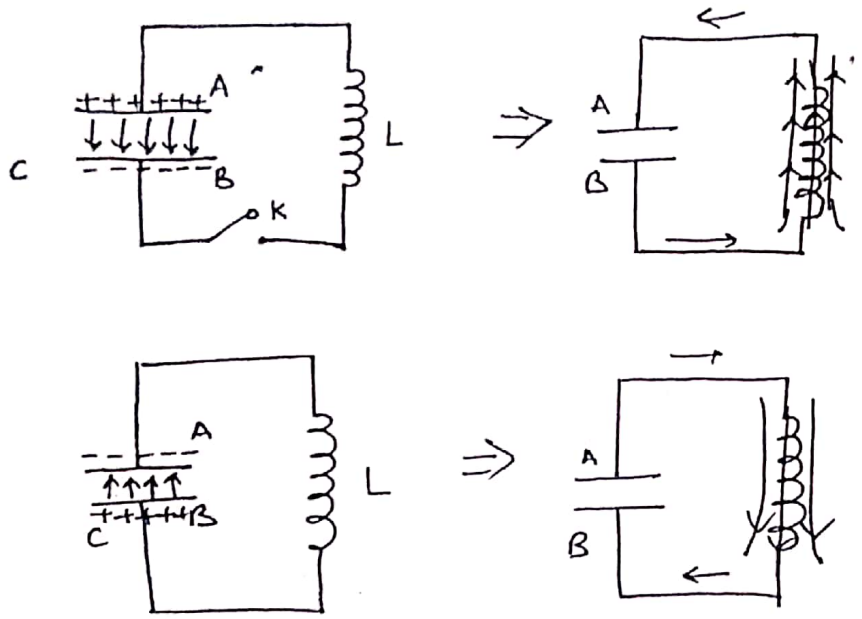
Working:→ If a time base voltage (saw tooth wave) is applied across x-plates and an alternating voltage is applied across y-plates the visible spot of light in addition to vertical displacement suffers horizontal displacement (time axis). Thus voltage to be studied is applied across y plates and time base voltage along x-plates.

Uses of CRO:→

1. Determination of amplitude of variable quantity.
2. Tracing the actual wave form of a periodical disturbance.
3. Measurement of voltages
4. Determination of phase difference between voltage and current
5. Determination of unknown frequency.
6. Tracing the Hysterisis curve.

Tank circuit (Principle of oscillations): →

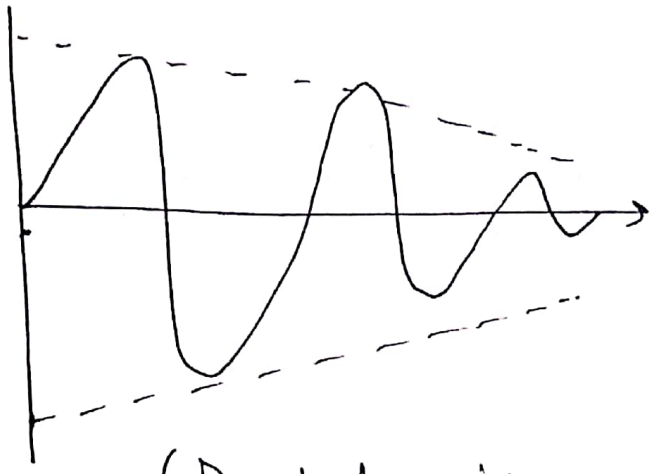
A tank circuit consists of a capacitor C with an inductance L connected in parallel with it. A tank ckt is basic unit of an oscillator. This ckt produces damped oscillations.



Consider a capacitor consisting of plates A and B. Let the plate A of capacitor be +vely charged and plate B have an equal amount of -ve charge. There will be electrostatic field between plates of capacitor, so that whole of the energy is stored as electrical energy of the capacitor. On closing the key K, plates A and B are connected with each other. The electrons from plate B move towards plate A and movement of electrons constitutes a flow of current in opposite direction. The mag. field is established in inductance coil. When the potential on two plates becomes equal, electric field disappears and whole of field is magnetic. Due to induced emf in coil movement of e⁻s will continue in same direction even after the potentials on two plates becomes equal. This process is repeated setting oscillatory current in the circuit. The freq of oscillations produced is,

$$\upsilon = \frac{1}{2\pi}\sqrt{\frac{1}{LC} - \frac{R^2}{4L}}$$

R = Resistance in circuit.



(Damped oscillations)

Classification of oscillators :—→

1. Positive feedback oscillator
2. sinusoidal oscillator
3. Relaxation oscillator (Non sinusoidal oscillator)
4. Audio frequency oscillator
5. Radio frequency oscillator
6. very high freq. oscillator
7. Ultra high freq. oscillator
8. Microwave oscillator

Barkhausen criterion of sustained oscillations :—→

Ordinary LC circuit (Tank circuit) produces damped oscillations. To produce undamped or sustained oscillations, a +ve feedback is given to input of oscillator, so that the oscillator produces a.c output signal without external input signal. Further, the amount of feedback must be

sufficient to overcome the losses.

Let A be voltage gain of amplifier and V be input signal. Then output signal is AV. Let β be fraction of output voltage transferred back to input signal, then feedback signal is βAV.

If $A\beta V = V$, Then amplifier will continue to supply its own input. Thus original input voltage is maintained at same level.

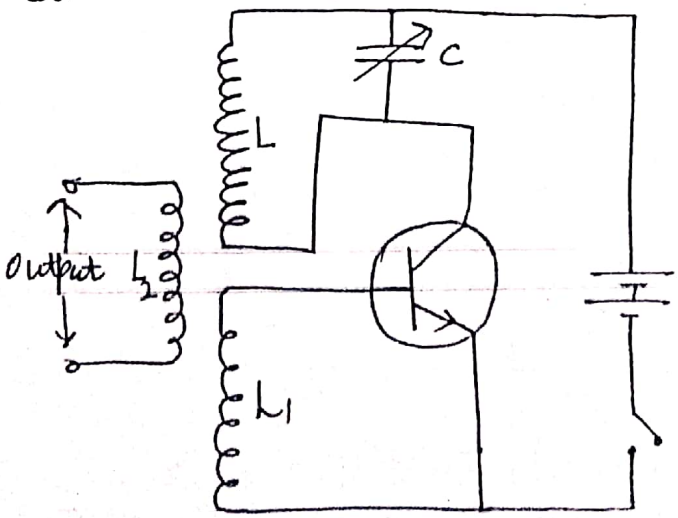
$$\therefore \quad A\beta V = V$$

$$\Rightarrow \boxed{A\beta = 1}$$

This condition is called Barkhausen criterian of sustained oscillations.

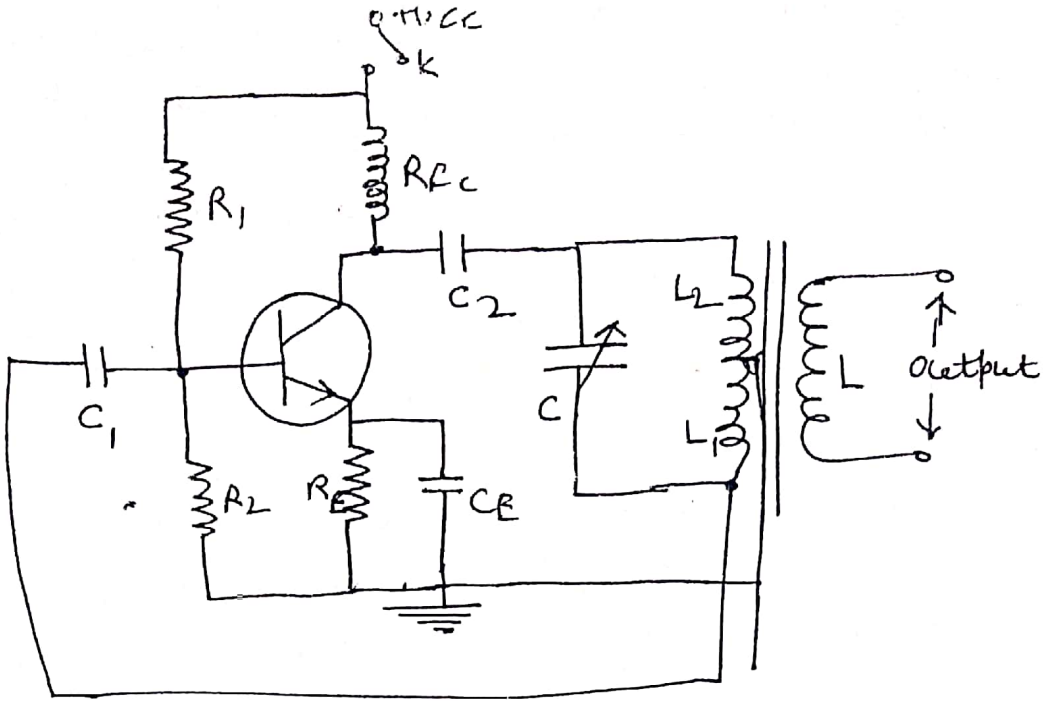
Common Emmiter Collector tuned oscillator →

Fig. below shows common emmiter collector tuned oscillator.



It is called tuned collector circuit, because tuned (tank) circuit is connected to collector of transistor. The tank circuit consists of capacitor C and primary coil L of transformer. The winding of secondary L_1 are connected to base circuit. The output is drawn across the inductance L_2. The small collector current flowing through coil L produces an induced emf in coil L_1, which gives a forward bias to emmiter base circuit. Thus emmiter current increases. The increase of emmiter current increases Collector current [$\because I_C \propto I_E$], and the process continues till the collector current is maximum. The collector current charges the plates of capacitor. As the collector current becomes saturated there is no induced emf in the coil L_1 and mag. flux through L_1 starts decreasing setting an emf in opposite direction. The capacitor also discharges and helps to decrease I_C. Thus emmiter base ckt is reverse biased, decreasing I_E and which decreases I_C till collector current becomes zero. The induced emf through L_1 is again zero. The I_E starts decreasing. At this stage, emmiter base circuit is again forward biased due to induced emf set up in it and the process is repeated again & again.

Hartley oscillator: → In Hartley oscillator, inductance coil L of tank circuit is divided into two parts L_1 and L_2, which are included in emmiter base and emmiter collector circuit respectively. The resistances R_1, R_L, R_E and V_{CC} helps in establishing a suitable operating point to the transistor. RFC is a radio frequency choke which permits easy flow of dc but offers very high impedance to AC.



The capacitor C_1 and C_2 are blocking capacitors. The feedback between output and input is accomplished through the transformer action. The capacitor C_2 does not allow d.c to flow to tank ckt and provide d.c, an easy path from collector to tank circuit.

When key K of collector circuit is pressed, collector current starts rising and charges the capacitor C. When the capacitor is fully charged, it discharges through inductor L_1 and L_2. Thus damped harmonic oscillations are set up in the tank circuit. The oscillations across L_1 are fed back to input circuit and will appear in amplified form in the input or base emmiter ckt.

In this way continuous undamped oscillations will appear in output circuit.

The freq. of oscillations produced is

$$\nu = \frac{1}{2\pi\sqrt{L_{eq}C}}$$

Where $L_{eq} = L_1 + L_2 + 2M$

M is mutual inductance

—X———X———X———