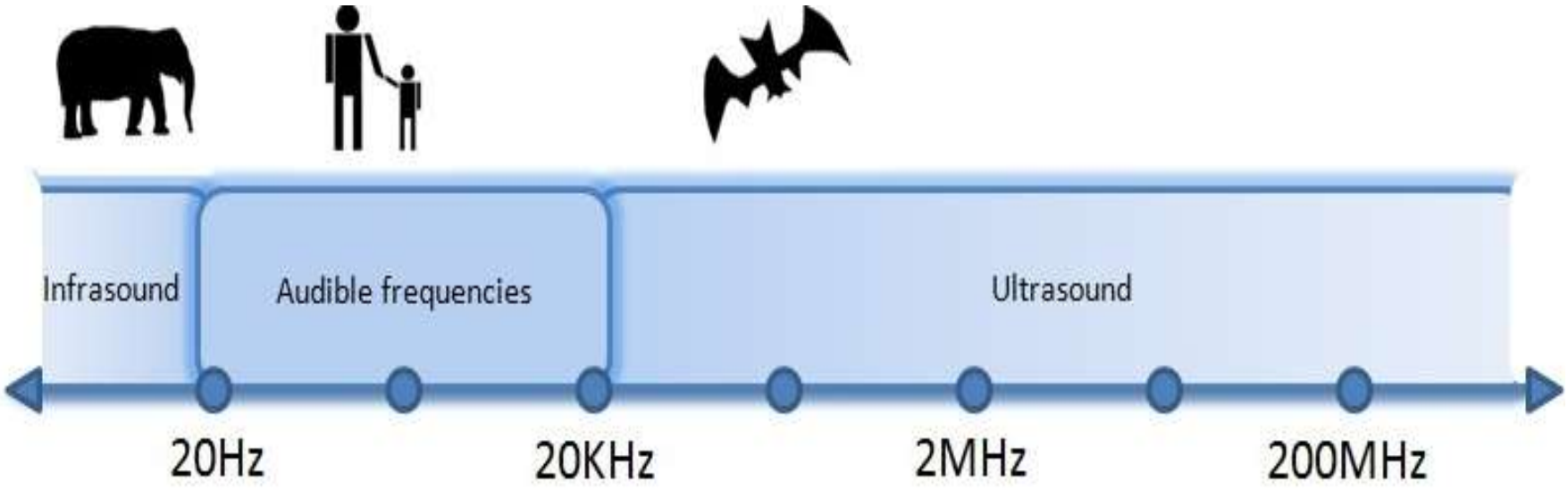
ULTRASONICS



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DEFINITION OF ULTRASONICS

ULTRASONICS is made up of two words “ULTRA” meaning BEYOND and “SONICS” meaning SOUND.

Sound waves in which the frequencies are above the limits of human audibility i.e. > 20 KHz are called ULTRASONICS.

SPECTRUM OF SOUND WAVES

FREQUENCY	DESCRIPTION	EXAMPLE
>20 Hz	INFRASOUND	EARTHQUAKES
20Hz-20KHz	AUDIBLE SOUND	MUSIC
<20 KHz	ULTRASONICS	BAT

PROPERTIES OF ULTRASONICS

- They have a large energy content.
- They can be transmitted over long distances without appreciable loss of energy.
- Velocity of ULTRASONIC waves depends on the temperature and frequency of the medium.
- Just like ordinary waves , ULTRASONIC waves get Reflected , Refracted and Absorbed.

ULTRASONICS PRODUCTION

ULTRASONICS can be produced by the following methods :

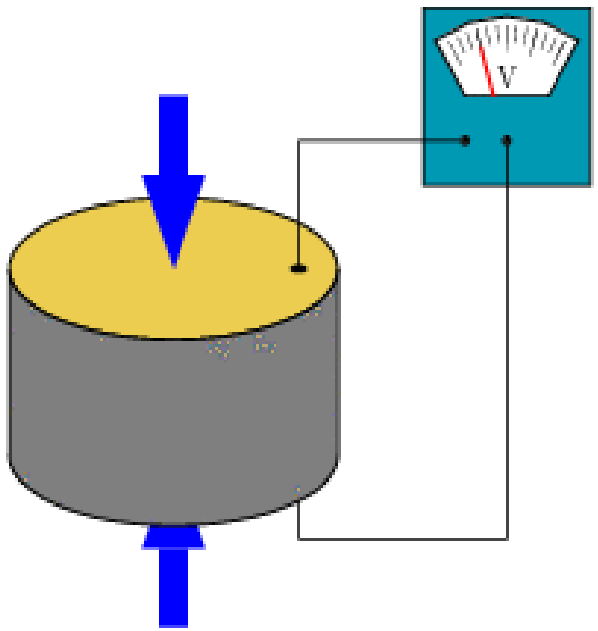
(1) Piezo-electric Generator

(2) Magneto-striction Generator

Piezoelectric Effect

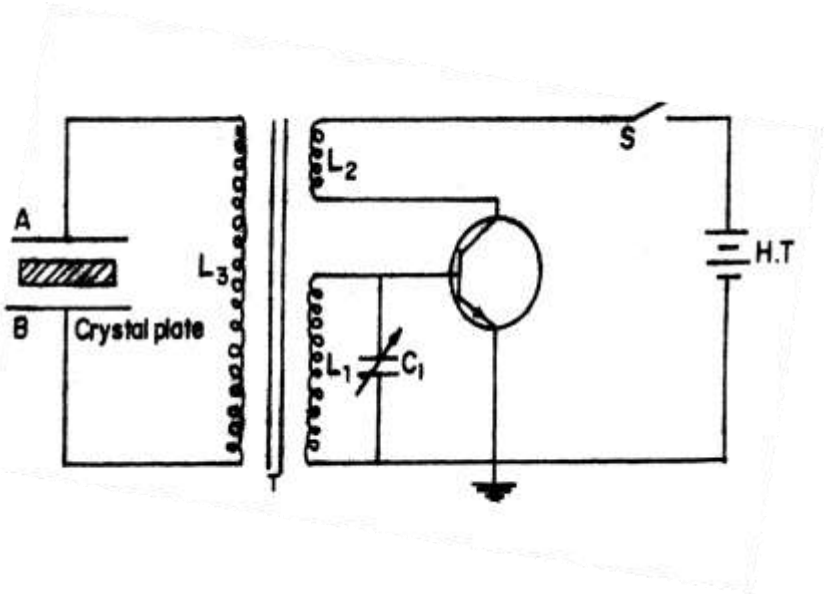
- If mechanical pressure is applied to the opposite faces of crystal , equal and opposite electrical charges appear across its other faces .This is known as Piezo-electric effect.
- Potential Difference developed would be proportional to pressure applied.
- The converse of Piezo-electric effect is also True.
- This effect was best observed in Quartz , Tourmaline etc.

Principle



If mechanical pressure is applied to the opposite faces of the crystal , potential difference is developed ,which would be proportional to the pressure applied .

Piezo-electric Generator



- The quartz crystal is placed between two metal plates A and B.
- The plates are connected to the primary (L_3) of a transformer.
- The coils L_1 and L_2 of oscillator circuit are taken from the secondary of a transformer.
- The collector coil L_2 is inductively coupled to base coil L_1.

Working of the Generator

(1) When battery is switched on, the oscillator produces high frequency alternating voltages with a frequency.

$$f = \frac{1}{2\pi\sqrt{L_1 C_1}}$$

(2)Due to the transformer action, an oscillatory e.m.f. is induced in the coil L_3. This high frequency alternating voltages are fed on the plates A and B.

(3) Inverse piezo-electric effect takes place and the crystal contracts and expands alternatively

(4) The frequency of the vibration is given by

$$n = \frac{P}{2l}\sqrt{\frac{Y}{\rho}}$$

ρ = density of the crystal.

Y=Young's Modulus.

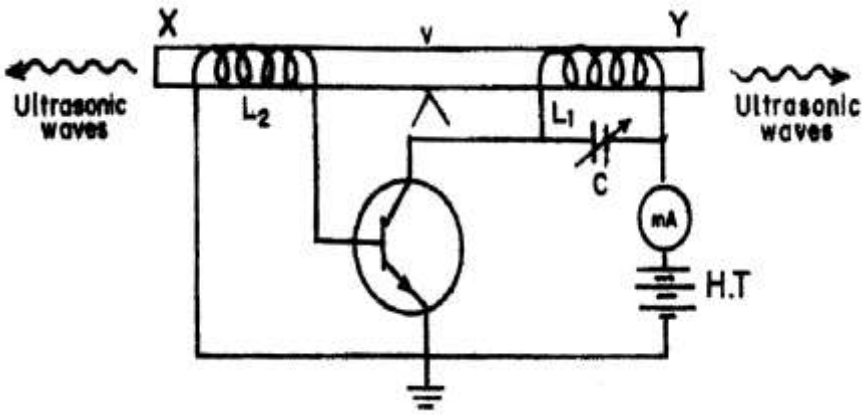
(5) The variable condenser C_1 is adjusted such that the frequency of the applied voltage is equal to the natural frequency of the crystal, and thus resonance takes place.

Magnetostriction Effect

- When a ferromagnetic rod like iron or nickel is placed in a magnetic field parallel to its length, the rod experiences a small change in its length . This is called magnetostricion effect .

- The change in length produced in the rod depends upon the strength of the magnetic field, the nature of the material and is independent of the direction of the magnetic field applied.

Magnetostriction Generator



- XY is a rod of ferromagnetic materials like iron or nickel.
- The alternating magnetic field is generated by electronic oscillator.
- The coil L_1 wound on the rod along with a variable capacitor C.
- The frequency of oscillator is controlled by the variable capacitor.

Working of the Generator

- When battery is switched on, the collector circuit oscillates with a frequency,

$$f = \frac{1}{2\pi\sqrt{L_1 C}}$$

- This current flowing through the coil L_1 produces an alternating magnetic field along the length of the rod.

- The frequency of vibration of the rod is given by

$$n = \frac{1}{2l}\sqrt{\frac{Y}{\rho}}$$

Y=Young's Modulus

ρ =density of rod material

- The capacitor is adjusted so that the frequency of the oscillatory circuit is equal to natural frequency of the rod and thus resonance takes place .
- Now the rod vibrates longitudinally with maximum amplitude and generates ultrasonic waves of high frequency from its ends.

Applications of Ultrasonic Waves

- Detection of flaws(cracks ,blowholes, porosity) in metals .
- In SONAR (SOund Navigation And Ranging).
- Ultrasonic welding.
- Ultrasonic cutting and machining.
- Ultrasonic soldering.

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