EXPERIMENT - 3

★ **Objective :-**

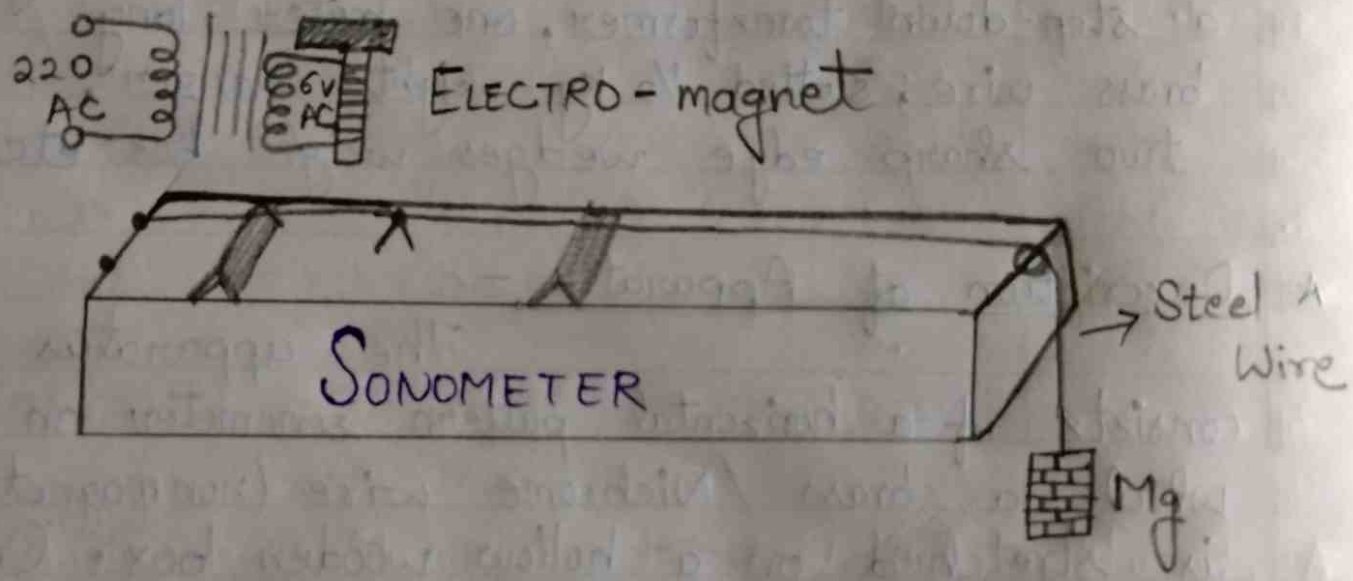
To determine frequency of A.C mains with a sonometer.

★ **Apparatus Required :-**

Sonometer, an electromagnet, a step-down transformer, one meter long brass wire, slotted ½ kg weights hanger, two sharp edge wedges weight box etc.

★ **Description of Apparatus :-**

The apparatus consists of a horizontal pattern sonometer on which a brass / Nichrome wire (non magnetic) is stretched on a hollow wooden box. One side of wire is tied to the hook, while the other passes over a frictionless pulley; As the A.C from the secondary of the step-down transformer passes through in windings of electromagnet, it gets magnetized with its faces as North and South pole and sonometer wire starts vibrating. This condition is achieved when the frequency of the alternating current


220
AC
6V
AC
ELECTRO - magnet
SONOMETER
Steel
Wire
Mg

passing through electromagnet is equal to the mechanical frequency of vibration of wire.

★ **Principal of working & formula used** –

A sonometer wire is stretched under a constant load and is placed in a uniform magnetic field at right angles to the wire in the horizontal plane. An alternating current of low volatage is passed through the wire. As a consequence the wire will execute forced vibrations with a frequency f of the a.c.

$$f = \frac{1}{2l}\sqrt{\frac{T}{m}}$$

Where l = resonat length, m = mass
$(T = Mg)$ is the tension of wire
M = Mass placed on hanger

If an alternating current is passed in the coil of the electromagnet, it will

vibrate with a frequency which is twice the frequency of alternating current. Hence, if f_{AC} is the frequency of the alternating current then,

$$f_{AC} = \frac{f}{2} = \frac{1}{4l}\sqrt{\frac{T}{m}}$$

★ Procedure -

(a) The apparatus is arranged as shown in the figure.

(b) Now the electromagnet is brought near the centre of the stretched wire.

(c) Measure the length measurement b/w two Knife edges A and C.

(d) Now observe the same by gradually decreasing the load.

$$F = \frac{1}{4l}\sqrt{\frac{T}{m}} \qquad T = Mg \qquad g = 98$$

$$f_1 = \frac{1}{4(26.75)}\sqrt{\frac{T_1}{0.0186}} = 47.9\,Hz \quad [T_1 = 500 \times 980]$$

$$f_2 = \frac{1}{4(37.75)}\sqrt{\frac{T_2}{0.0186}} = 48.07\,Hz \quad [T_2 = 1000 \times 980]$$

$$f_3 = \frac{1}{4(46)}\sqrt{\frac{T_3}{0.0186}} = 48.31\,Hz \quad [T_3 = 1500 \times 980]$$

$$f_4 = \frac{1}{4(52.75)}\sqrt{\frac{T_4}{0.0186}} = 48.6\,Hz \quad [T_4 = 2000 \times 980]$$

$$f_5 = \frac{1}{4(58.5)}\sqrt{\frac{T_5}{0.0186}} = 49.04\,Hz \quad [T_5 = 2500 \times 980]$$

Mean frequency $\Rightarrow$ 48.384

$$\% \text{ error} = \frac{48.384 - 50}{50} \times 100$$

$$\% \text{ error} = -3.232\%$$

★ Observations :-

Mass per unit length of wire
$m = 0.0186$ gm/cm.

S. NO.	Load with Hanger (M gm)	Length of Wire on Increasing load (l_1 cm)	Length of Wire on Decreasing load (l_2 cm)	Mean Length l cm = $(l_1+l_2)/2$	Frequency of A.C. mains f_{AC} Hz
1.	500	26	27.5	26.75	47.9 Hz
2.	1000	37	38.5	37.75	48.07 Hz
3.	1500	45.5	46.5	46	48.31 Hz
4.	2000	52	53.5	52.75	48.6 Hz
5.	2500	58	59	58.5	49.04 Hz

★ Calculations :- $T = Mg$, $g = 980$ cm/s^2

Calculate the freq. using following formula

$$f_{AC} = \frac{f}{2} = \frac{1}{4l}\sqrt{\frac{T}{V}}$$

★ Result :-

48.384 = x

Mean frequency of A.C mains = [redacted] Hz

Frequency of A.C mains in India = 50 Hz

$$\% \text{ error} = \frac{x - 50}{50} \times 100 = -3.232\%$$

★ Precautions :-

(a) Vibrator should not touch the sonometer wire.

(b) The wire must be uniform without kinds or unevenness.

(c) The knife edges should be shifted slowly so that correct resonance length is found.