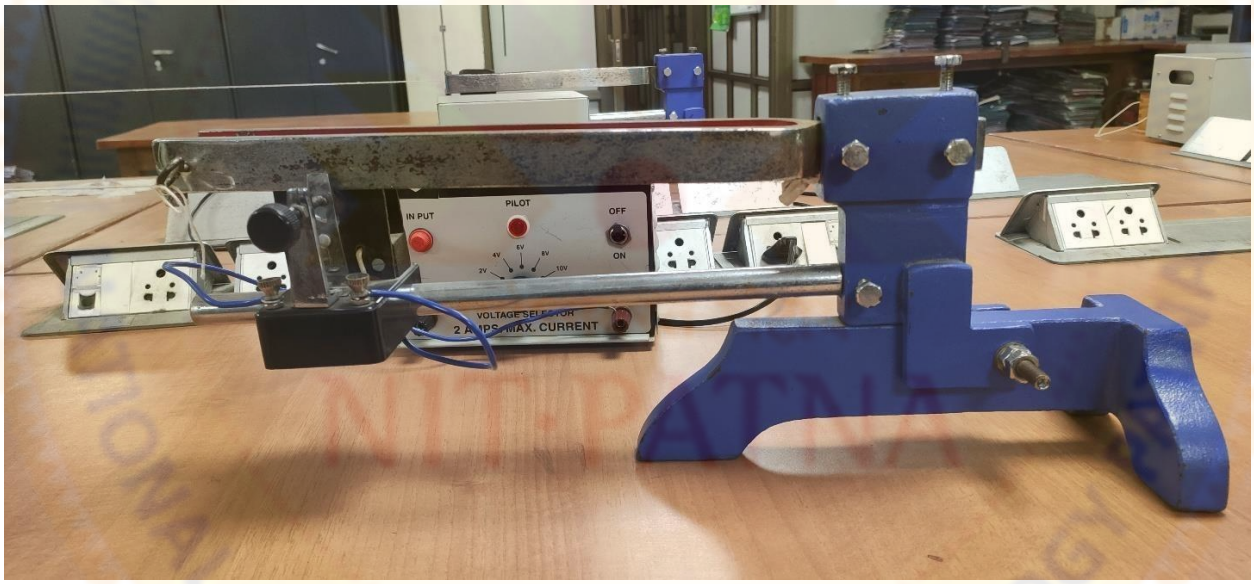
LABORATORY MANUAL TO MEASURE THE FREQUENCEY OF A TUNING FORK BY MELDE'S EXPERIMENT



AIM

TO MEASURE THE FREQUENCEY OF A TUNING FORK BY MELDE'S EXPERIMENT IN BOTH LOGITUDINAL AND TRANSVERSE MODE.

APPARATUS

1. Electrically maintained tuning fork.
2. Power supply. (set at maximum 6−8 V)
3. Pan with thread and pulley.
4. Scale.
5. Pin stands -2
6. Weight box.

THEORY

When a vibrating body produces waves along a tightly stretched string, the waves are reflected at the end of the string, which cause two opposite traveling waves to exist on the string at the same time. These two waves interfere with each other, creating both constructive and destructive interference in the vibrating string. If the two waves have identical amplitudes, wavelengths and velocities, a standing wave or stationary wave is created.

The constructive and destructive interference patterns caused by the superposition of the two waves create points of minimum displacement called nodes, or nodal positions, and points of maximum displacement called antinodes. If we define the displacement between two nodes (or between two antinodes) to be L, then wavelength of standing wave is $\lambda = 2L$.

If "L" be the loop length "T" be the tension in string and "μ" be the mass per unit length, then velocity of wave in the string is $V = n\lambda \left(\text{where } V = \sqrt{\frac{T}{\mu}}\right)$

∴The frequency ($\boldsymbol{n}$) of string as given by: $\boldsymbol{n} = \frac{\mathrm{V}}{\lambda}$

$$\boldsymbol{n = \frac{1}{2L}\sqrt{\frac{T}{\mu}}}$$

In this experiment one end of a uniform light string is tied to one prong of an electrically maintained tuning fork at the up and the other end passed over a pulley and is tied to a pan. When the string attached to the vibrating fork is set into vibration its two fixed ends become nodes of the standing wave since they are not free to vibrate. The tuning fork can be held into two positions.

(a) Longitudinal Position:-

In this position the string and the pong of the fork are perpendicular to each other. In this case when the fork makes one complete vibration the string makes half a vibration. Hence, in the longitudinal position, the frequency of vibration of the string will be half that of the fork.

If frequency of the tuning fork is N, then for longitudinal position: $N = 2n$.

(b) Transverse Position:-

In this position the string and the prong of the fork are parallel to each other and described. Their half-cycle in same interval of time. Hence, in the transverse position, the frequency of the string is equal to that of the fork.

If frequency of the tuning fork is N, then for longitudinal position: $N = n$.

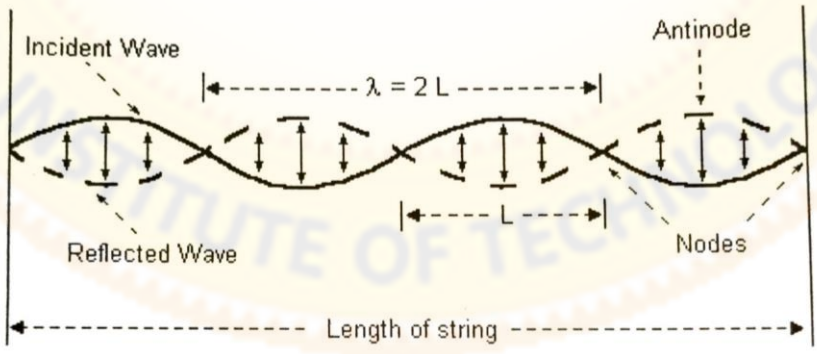


Fig :- A standing wave is created when an incident and reflected wave have identical amplitudes, wavelengths and velocities.

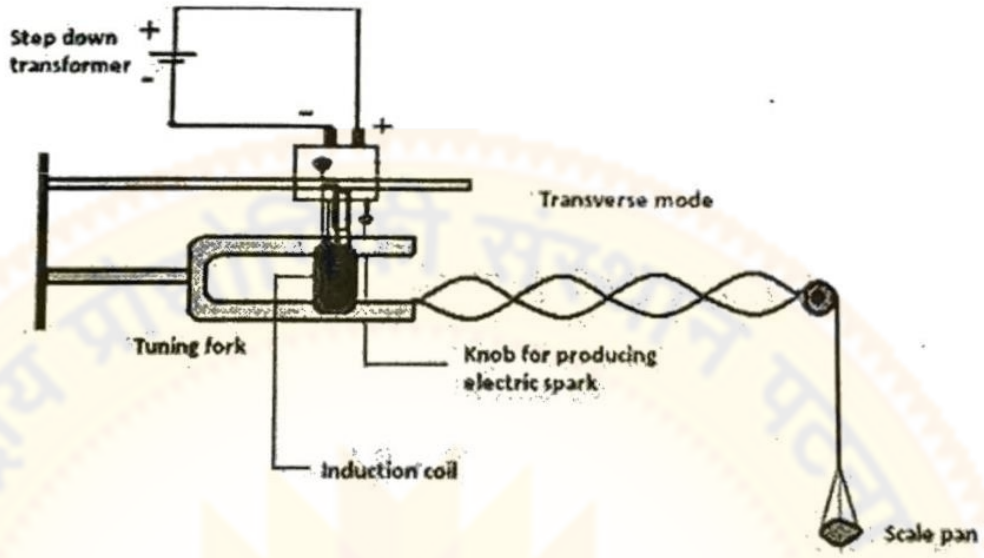


Fig :- Transverse arrangement

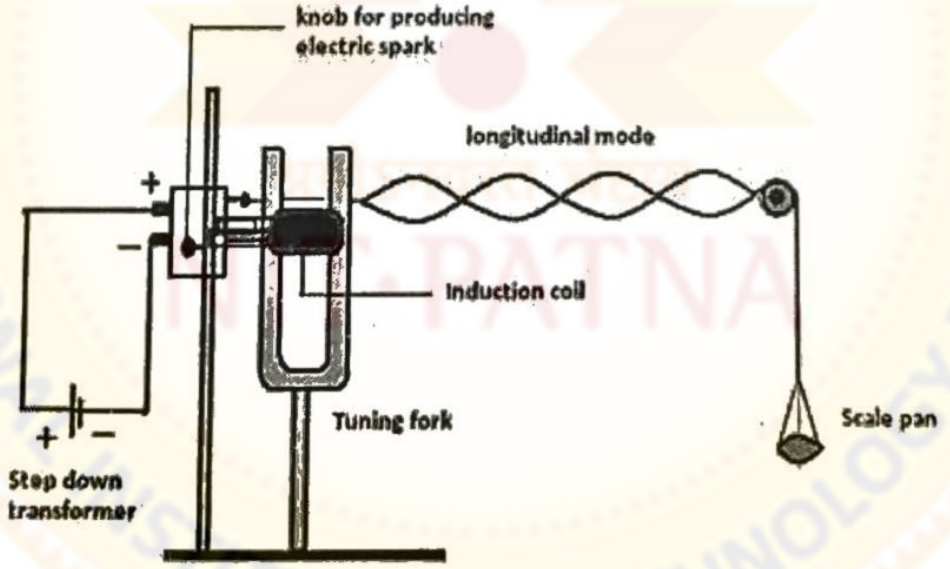


Fig :- Longitudinal arrangement

PROCEDURE

1. Electrically maintained fork is placed on the longer side of the working table at the edge. One end of a uniform string about 1.5 m long is tied to one prong of fork at the tip. The other end of string passed over a pulley fixed at the other end of the table. The fork can be placed in longitudinal of transverse position as desired.

2. Initially, arrange the setup in transverse mode of vibration.

3. Some weight say 10 gm. is placed on the pan. Then turn on the power supply. Now rotate the knob slowly so that electrical spark is generated. This will happen when the knob is loosely touching the other end of the circuit. This will initiate the vibration of the tuning fork.
4. Tuning fork is set into vibration and required adjustments are made to obtain a standing wave with nodes and anti-nodes.
5. Loop length is measured by placing two pin stands under two consecutive nodes.
6. A number of observations are made for the same tension "T" in the string. Different sets of measurements are made by varying the tension by increasing the masses such as 10 gm, 20 gm, …. 50 gm. In each case measure the loop length and count the no. of loops. You will find that loop length is increasing with the increase in masses.
7. Now arrange the set up in longitudinal mode of vibration. Place the masses starting from 2 gm, 5 gm, … 30 gm and measure the loop length in each case and note the no of loops.
8. At the end of experiment note down the mass of the pan which is mentioned below the pan itself.

***** You can increase the masses until two loops are formed. For perfect loops the arrangement should be properly aligned. Make sure you are turning on the circuit only when you are ready to take data. The circuit should be on for a maximum of 1 min during taking each reading. If the circuit is kept on for a long time the coil will heat up and may damage the power supply. Understand the mechanism behind the vibration of the tuning fork by electrical power supply.***

OBSERVATION

The frequency of a Tuning Fork by Melde's Experiment

Weight of Pan (m_p) = check bottom of the pan, Mass per unit length of the thread (μ) = $0.26 \times 10^{-3}\ kg/m$

Acceleration due to gravity (g) = 9.81 m/s^2

Least count of the meter scale = ….

Table for finding the frequency of the tuning fork for both mode.

- **For Transverse Mode:**

No. of obs.	Position of the fork	No. of loops	Loop Length	M (Unit)	'T' ($\times 10^{-3}$) = $(M + m_p)g$ (N)	n (Hz)	N = n (Hz)	Average N (in Hz)
1								
2								
3								
4								
.								

Frequency of the Tuning fork determined by Transverse mode (N) = _____Hz.

- **For Longitudinal Mode:**

No. of obs.	Position of the fork	No. of loops	Loop Length	M (Unit)	'T' ($\times 10^{-3}$) = $(M + m_p)g$ (N)	n (Hz)	N = 2n (Hz)	Average N (in Hz)
1								
2								
3								
4								

Frequency of the Tuning fork determined by Longitudinal mode (N) = _____Hz.

CALCULATION

Show all the calculation in determining n (frequency of the wave in string) and N (frequency of the tuning fork).

RESULT

The final frequency of the tuning fork will be average of the frequency obtained in both transverse and longitudinal mode.

ERROR CALCULATION

$$n = \frac{1}{2L}\sqrt{\frac{T}{\mu}}$$

By using the above formula find the Δn for a certain value of T and L.

PRECAUTION AND DISCUSSION

1. The power supply should not be kept on for a long time.
2. While rotating the knob it should be gently touching the other end otherwise spark will not be generated and the fork will not vibrate if the knob is made too tight.
3. Hold the lower part of the tuning fork by one hand if it is shaking too much shifting its position on the table.
4. If in any case a loop is not completely form or half formed, the string length can be increased or decreased by adjusting the tuning fork position.