Experiment: To verify the laws of vibrating strings by Melde's experiment that is to show that λ^2/T = constant.

Apparatus: Electricity maintained tuning fork, a stand with clamp, pulley a lightweight pan, a weight box, a balance, a battery of two cells, a key, a rheostat connecting wires etc.

Theory: In Melde's experiment, the stretched string is set in motion by the vibrator support, but if the frequency of vibration is not one of the natural frequencies of the string the vibrational amplitude of the string is very small. However, when the frequency *f* of the vibrating support is the same as one of the natural frequencies of the string the vibrational amplitude will be larger and will exhibit clearly defined nodes and loops corresponding to the standing wave of the particular frequency. The equations needed are simply given here.

In transverse arrangement.

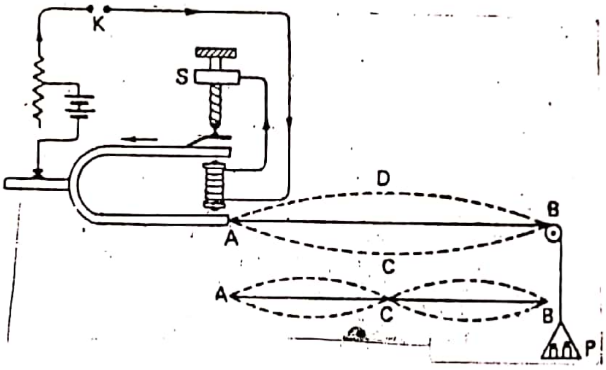
$$f = \frac{n}{2L}\sqrt{\frac{T}{m}} = \frac{1}{\lambda}\sqrt{\frac{T}{m}}\left(\because \frac{2L}{n} = \lambda\right)$$

$$\frac{\lambda^2}{T} = \left(\frac{1}{f^2 m}\right) = k_1 (cons\tan t)$$

In longitudinal arrangement.

$$f = \frac{n}{L}\sqrt{\frac{T}{m}} = \frac{2}{\lambda}\sqrt{\frac{T}{m}}$$

$$\frac{\lambda^2}{T} = \left(\frac{4}{f^2 m}\right) = k_2 \text{ (constant)}$$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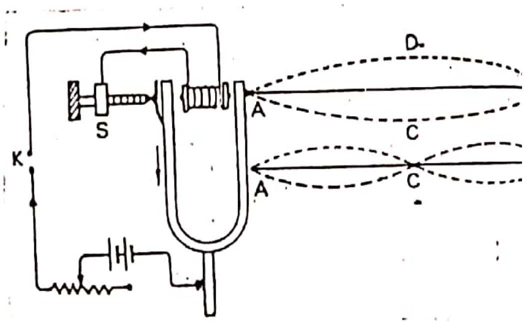
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Where:

F is frequency of stationary waves.

λ is wavelength of stationary waves.

n is segments/loops in the stationary wave.

L is string length.

T is tension in the string

m is mass per unit length of string.

Procedure:

1. The setup used in this experiment is shown in fig. 1 for transverse arrangement and in fig. 2 for longitudinal arrangement. The power supply drives the vibrator (Tuning Fork). A string is attached to the vibrator at one end, a weight pan (P) at the other, stretched over the pully which is clamped to the lab bench.
2. Place small weights in the pan attached to the end of the string.
3. Switch on the power supply and adjust the screw (S) to drive the vibrator.
4. Adjust the position of the pulley so that the string is set into resonant vibrations and well-defined loops are obtained. If necessary, adjust the tension by adding weights in the pan slowly and gradually. For finer adjustment, add milligram weights so that the nodes are reduced to points.
5. Measure the length of the loops formed in the middle part of the string. If L is the distance in which n loops are formed then distance between two consecutive nodes l = L/n.
6. Note down the weight placed in the pan and calculate the tension T. Tension T = (weights in the pan + weight of pan) x g.
7. Repeat the experiment twice by changing the weight in the pan. Alter the position of the pulley each time to get well-defined loops.

8. Measure one metre length of the thread and find its mass to find the value of m, the mass per unit length.
9. Set the apparatus as shown in Fig. 2 and proceed with the adjustments and measurements as explained above.

Observations:

(i) Mass of the pan (P) w = ...gm

(ii) Transverse arrangement:

S. No.	n No. of loops	L Length of the thread (metre)	$\lambda = 2L/n$ (metre)	W Mass in the pan (kg)	T=(W+w)g Tension	$\frac{\lambda^2}{T}$
1.						
2.						
3.						

(iii) Longitudinal arrangement :

S. No.	n No. of loops	L Length of the thread (metre)	$\lambda = 2L/n$ (metre)	W Mass in the pan (kg)	T=(W+w)g Tension	$\frac{\lambda^2}{T}$
1.						
2.						
3.						

Vérification :

Within the limits of experiments error λ^2/T is constant. Hence the law is verified.

Precautions:

1. The thread should be uniform and inextensible
2. The thread should be horizontal and in alignment with the tuning fork. In transverse arrangements, the thread should be stretched in line with the length of the prong so that the vibration of the thread should be in line with the line of vibration of the prong.
3. Well-defined loops should be obtained by adjusting the tension with milligram weights.
4. Friction in the pulley should be least possible as otherwise it causes the tension to be less than the actual applied tension.
5. The loops in the central part of the thread should be counted for measurements. The nodes at the tip of the prong and at the pulley should be neglected as these have some motion.

Sources of error:

1. The friction at the pulley and sparking at the platinum points cannot be totally eliminated.
2. There is a change in frequency due to the clamping screw at the tip of the prong of the tuning fork.