**6. Melde’s Apparatus (Photo and diagram)**

* 1. **AIM**

To observe standing waves on a string created by oscillating a tuning fork.

To determine the frequency of tuning fork using Melde’s Apparatus.

**6.2 PRINCIPLE**

A stretched string is attached to a tuning Fork. When this fork vibrates , standing wave are formed on the string. This is clearly visible as well defined loops. The frequency (ν) of the vibrations is given by -

1. Transverse arrangement:

1. Longitudinal arrangement:

Where

- Length of each loop,

T - Tension applied,

µ - Mass per unit length of string.

ν - Frequency of tuning fork

**6.3 EQUIPMENTS REQUIRED**

Table I : Equipment and the items required for performing the experiment.

|  |  |  |
| --- | --- | --- |
| **S. No.** | **Required item** | **Utility** |
| 1 | Pulley | **To hang the pan with weights** |
| 2 | Stand | To hold the pulley |
| 3 | Tuning Fork | To create vibrations |
| 4 | Connecting Wires | To facilitate power supply |
| 5 | Weight Box | To change the Tension |
| 6 | Pan | To hold the Weights |
| 7 | Thread | To connect the pan and Tuning Fork |
| 8 | Power Supply | To vibrate the Tuning Fork |

Figure 1: Photograph of the Melde’s apparatus.

* 1. **PROCEDURE**

The following quantities are directly measured in this experiment.

Table II : The details of the physical quantities to be measured.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| S.No | Physical quantity | Independent /  Dependent | Measured  with | Measuring instrument’s | | |
| Minimum | Maximum | Least count |
| 2 | Length | dependent | Meter scale |  |  |  |
| 3 | Mass | independent | Weighting machine |  |  |  |

b

1. Take one meter of string and pass over the pulley. Attach a pan of known weight to one end and tie the other end to the tuning fork.
2. Arrange the tuning fork along the length of the string. This creates transverse vibrations in the string.
3. Also measure the weight of a known length of the string used in the experiment. Note down these values to calculate the mass/unit length.
4. Now, close the circuit and adjust the screw is till the fork vibrates steadily.

DO NOT TIGHTEN THE SCREW, WHEN IT IS JUST TOUCHING THE METAL STRIP A SPARK WILL BE OBSERVED.

DO NOT USE VOLTAGE MORE THAN 6V.

1. Move the tuning fork (keeping the tension constant) until a single loop is formed with well-defined nodes.
2. Take care that the vibrations of the string are in the horizontal plane.
3. Note down the length of the string from the pulley to the tuning fork.
4. Repeat steps 4-7 to obtain different no of loops by moving the tuning fork away from the pulley.
5. Repeat the above mentioned steps by arranging the tuning fork perpendicular to length of the string. This creates longitudinal vibrations in the string

**How to measure Mass per unit length of string:**

1. Take some string of length “l” meter.
2. Calculate the mass of the string. (m gm)
3. Mass per unit length:

Weight of the pan (m) =

Length of the string used in the experiment =

Mass of the string =

Table III: Table for transverse and longitudinal arrangment.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| S. No | Load applied in the pan (M gm) | Tension  dynes | No. of Loops  “X” | Length of ‘X’ loops  (d cm) | Length of each loop  cm |
| **1.** |  |  |  |  |  |
| **2.** |  |  |  |  |  |

* 1. **STUDY QUESTIONS**

1. How is the tuning fork vibrated in the apparatus?
2. Is there any method to check the correctness of the result?
   1. **FURTHER SCOPE OF EXPERIMENTS**
3. Keeping the load in the pan constant, vary the length of the string so that well-defined loops are formed. Repeat the same experiment using the above changes.
4. Determine the speed of the wave.
   1. **PRECAUTIONS**
5. Take care that the string be aligned in a straight line.
6. Adjust the screw properly. Do not tighten it to a large extent.
7. Do not operate the tuning fork for a long time. When readings are not taken, switch it off.
   1. **SOURCES OF ERROR**
8. Improper alignment of apparatus.
9. Using the apparatus for a long time at a stretch.
   1. **THEORY**
10. Transverse arrangement:

The fork is placed in the transverse position and the lengthy of string is fixed. By changing the load in the pan, well-defined loops are formed. This is due to the formation of stationary waves due to the superposition of waves from the prong and the reflected waves from the pulley. Well-defined loops are formed when the frequency of each segment coincides with the frequency of the fork. The frequency can be given by

Where

η = Frequency of Tuning Fork,

= Length of each loop,

T = Tension applied,

µ = Mass per unit length of string.

1. Longitudinal arrangement:

When the fork is placed in the longitudinal position and the string vibrates, the frequency of the stretched string will be half of the frequency η of the tuning fork. That is, when the well-defined loops formed on the string, the frequency of each vibrating segment is exactly half of the frequency of the tuning fork.

During longitudinal vibrations, when the prong is in its right extreme position, the string corresponding to a loop gets slackened and it moves up to its initial horizontal position and becomes light. But when the prong is again in its right extreme position, it completes one vibration. So, the string goes up; its inertia carrying it onward and thereby completing half a vibration. The frequency of each loop is

And the frequency of tuning fork is

Where

η = Frequency of Tuning Fork,

= Length of each loop,

T = Tension applied,

µ = Mass per unit length of string.

* 1. **FURTHER READING AND RESOURCES**

**Text books**

Book - Gardner, Robert, 1990. *Famous Experiments You Can Do.* New York, NY: Franklin Watts (pp. 103–104).

**Internet**

Internet -Blauch, D., 2004. "Gas Laws: Pressure", Department of Chemistry, Davidson College [accessed January 23, 2006]  <http://www.chm.davidson.edu/ChemistryApplets/GasLaws/Pressure.html>

**Java apps/apps**

University of Colorado, B. (n.d.). *Masses & Springs*. Retrieved from PhET Interactive Simulations: [**https://phet.colorado.edu/en/simulation/mass-spring-labA**](https://phet.colorado.edu/en/simulation/mass-spring-labA)

**Videos**

1. Andersen, P. (2014, August). *Simple Harmonic Motion, Bozeman Science*. Retrieved from YouTube: <https://www.youtube.com/watch?v=tudxily5Qu0>
2. Lewin, W. H. (1999). MIT 8.01 Physics I: Classical Mechanics, Fall 1999. *Lecture 10: Hooke's Law - Springs - Simple Harmonic Motion - Pendulum - Small Angle Approximation*. Retrieved from Internet Archive:<https://ia601409.us.archive.org/6/items/MIT8.01F99/10.mp4>

**Bibliography**