

String Oscillograph

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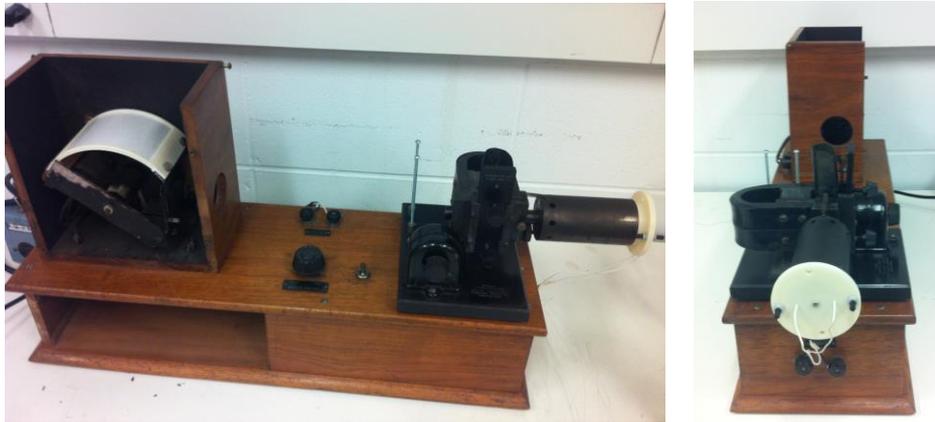


Figure 1 Oscillograph.

String Oscillograph, first offered by General Radio in 1928, is a device that enables one to observe waveform of an electrical current in real time. This is accomplished by the following implementations. A very fine tungsten wire is positioned in a magnetic field supplied by a permanent magnet. When an electrical current flows through the wire, the wire will get deflected where the displacement of deflection is proportional to the amplitude of applied current. The string, being suspended in a beam of a powerful lamp, will then cast a shadow of itself upon an arc screen. Before the shadow strikes the screen, it will get reflected from an octagonal non-synchronous mirror, which rotates about an axis parallel to the line of string's vibration, and be given an additional displacement that is proportional to time. As a result, string oscillograph converts waveform of electrical current into mechanical vibration, which is represented by spots of shadows well spread over the screen, eventually reproducing the waveform of the current which can be easily observed and studied.

String oscillograph consists of three parts, the galvanometer unit, the viewing box and a walnut cabinet base which the two are mounted.

❖ Galvanometer Unit



Figure2. Galvanometer Unit.

- Optical System: An additional incandescent lamp, operated at 8 volts supplied by a built-in transformer, is needed to provide an illuminated field. Focus lens are arranged to compress the light beam so as to improve the definition of the spot of light on the screen. The knob below the lens is for adjusting focus.



Figure 3 3D-printed Lamp Holder.



Figure 4 Lens.

- String and String Holder: A string holder is provided to hold a piece of very fine tungsten wire, with 0.0004 inch in diameter. The string has a resistance of about 45 ohms and is approximately 3 inches in length. Two adjustment screws are provided at the back of the holder. One varies the tension on the string while the other serves to displace the string as a whole across the light beam to center the image on the screen. The string holder is removable from the galvanometer. Electrical contact is made through two springs on the galvanometer base.



Figure 5 Fine tungsten wire.



Figure 6 String Holder.



Figure 7 Gap for String's Oscillation.

- Potentiometer: By changing resistance of variable resistor in the potentiometer, amplitude of the current flowing through the wire and thus amplitude of waveform displayed on the screen become adjustable. The original potentiometer (Figure 10) was found broken and then replaced by a new one with 250 ohms (Figure 11).



Figure 8 Adjustment Knob of the Potentiometer.

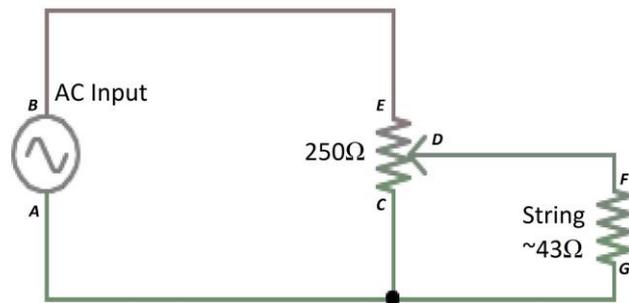
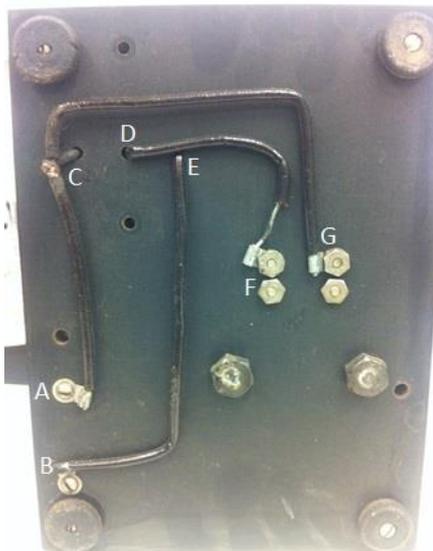


Figure 9 Connections and Schematic of the Potentiometer.



Figure 10 Broken Potentiometer.



Figure 11 New Potentiometer.

❖ Viewing Box



Figure 12 Viewing Box (Including the Screen Holder).

A shaded-pole motor that is non-synchronous drives the octagonal rotating mirror. Its speed can be adjusted by a “motor-control” knob on the cabinet base in order to synchronize with any desired frequency carried by the current and to produce a stationary image of the waveform. Above the motor, an arc-shape

screen holder is arranged which can hold a translucent paper of dimension 4.78 inch x 3.41 inch as screen. A piece of cylindrical glass is placed in front of the mirror to further converge the light.

- Shaded-pole Motor

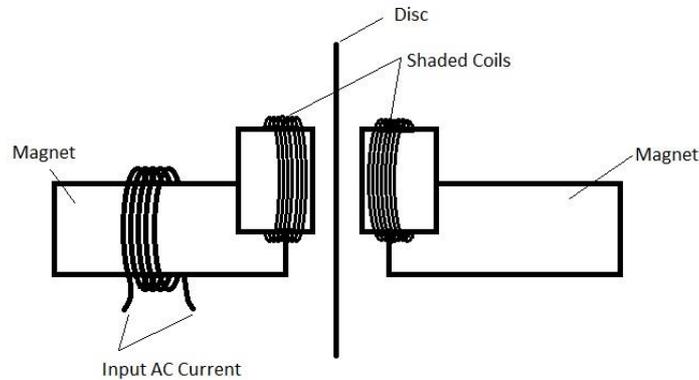


Figure 13 Shaded-pole Motor.

In such arrangement, as the current in the coil keeps changing, the change of magnetic field in the shaded pole area is delayed, which results in a spatially periodically rotating magnetic field. As the maximum field intensity moves across the pole face on each cycle, the interaction between the existing magnetic field and induced eddy-currents on the aluminum disk provided torque for rotation of the disk.

- Octagonal Mirror



Figure 14 The Octagonal Mirror.

- 3D-printed Screen Holder

- ❖ Cabinet Base and Controls

- Power Supply: 110 volts, 60 cycles.
- Frequency Range: 0 to 2000 cycles per second.
- On-off switch



Figure 15 Control Board.

- Light Source: 8 volts delivered for the light source.
- Cond
A condenser of capacity 3.477 μF is provided to filter out DC component of the input current if desired.



Figure 16 Condenser.

Bibliography

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