

## MISCELLANEOUS LABORATORY EQUIPMENT

**I**N this chapter are listed three important pieces of miscellaneous laboratory equipment: the General Radio string oscillograph and vibration galvanometer, electric wave-filter sections, and artificial-cable boxes. Each is described under its own heading:

- a) String Oscillograph Vibration Galvanometer
- b) Electric Wave-Filter Section
- c) Artificial-Cable Boxes

### STRING OSCILLOGRAPH AND VIBRATION GALVANOMETER

**I**N many lines of work and experimentation with alternating currents, the need is frequently felt for a simple, sensitive, portable, and inexpensive oscillograph, with which one may view with ease either sustained waveforms or transient currents and voltages existing at any point in an electric circuit or network. To meet these requirements, the General Radio Company has designed a compact and moderately priced instrument.

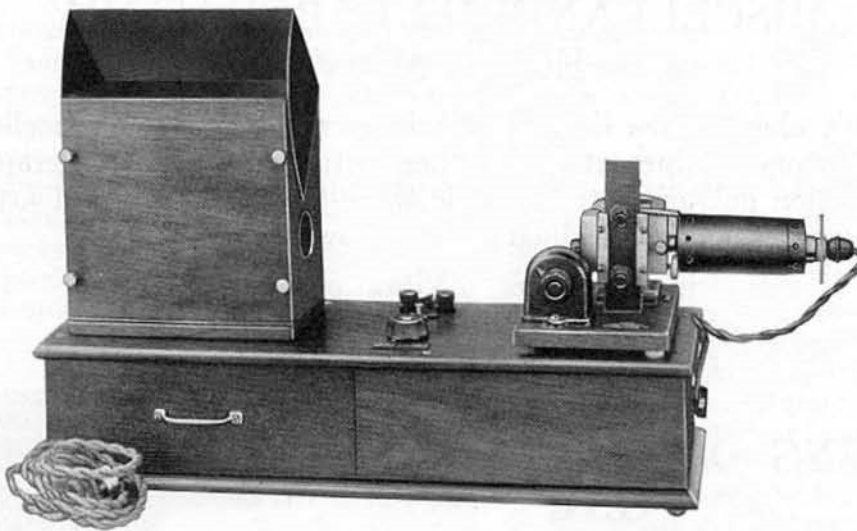
The vibrating element of the oscillograph is a fine tungsten wire fixed in a magnetic field supplied by permanent magnets. The current under observation passes through this string and is deflected by the interaction of its own field with that supplied by the permanent magnet. The string, being suspended in the beam of a powerful incandescent lamp, casts a shadow upon a suitable screen, thus furnishing a means of observing the amount of deflection.

Equipped with a lens system and a fixed screen, the instrument is useful as a vibration galvanometer, since the string may be tuned to give a good degree of sensitivity at any desired frequency over a considerable range.

If instead of a fixed screen, the shadow of the string is cast upon a rotating mirror, the speed of which is adjustable, the wave of either current or voltage may be traced out. For many kinds of work, the portability, ruggedness, and low cost of this oscillograph make it especially desirable. The strings are inexpensive and easily replaced, an advantage when the oscillograph is to be used by students in laboratory classes.

#### TYPE 338 STRING OSCILLOGRAPH AND VIBRATION GALVANOMETER OSCILLOSCOPE MODEL

**T**HIS instrument consists of three parts, the galvanometer unit, the viewing box which contains the rotating mirror, and a walnut cabinet base upon which the two are mounted. The latter carries all the necessary controls. An eddy-current type of motor which is non-synchronous drives the octagonal rotating mirror. Its speed may be



TYPE 338-L

adjusted so as to synchronize with any desired impressed frequency and to produce thereby a stationary image of any recurrent waveform. The observed waveform consists of a shadow line projected upon an illuminated field.

*Rotating Mirror and Optical System:* A single straight tungsten wire is vibrated in the focal plane of an easily adjusted and focused optical system. The shadow image of this wire, after reflection from the rotating mirror which provides the time axis, is focused directly upon the observing screen. Ponderous and troublesome mirrors are thus avoided. The translucent screen is arranged in the arc of a circle, approximately 6 inches long by  $2\frac{1}{2}$  inches wide, and is printed with rectangular coordinates for convenient reference. Stable speed range of mirror, equivalent to scale length of from 30 to 250 inches per second.

*Galvanometer and String:* The galvanometer unit is sensitized by two permanent magnets which eliminate the need for direct-current excitation. The characteristics of the strings are described later

under TYPE 338 Accessories. Two TYPE 338-P1 Single String-Holders are supplied.

*Frequency Range:* Optimum, 0 to 200 or 300 cycles per second. Usable, 0 to 3000 cycles per second.

*Light Source:* Transformer operated from 110-volt, 60-cycle power supply, delivers 8 volts for lighting standard automobile headlight lamp.

*Mounting:* Galvanometer and lamp housing, viewing box containing rotating mirror, and all controls mounted on cabinet base. Whitewood carrying case, (30 x 18 x 11 inches) supplied.

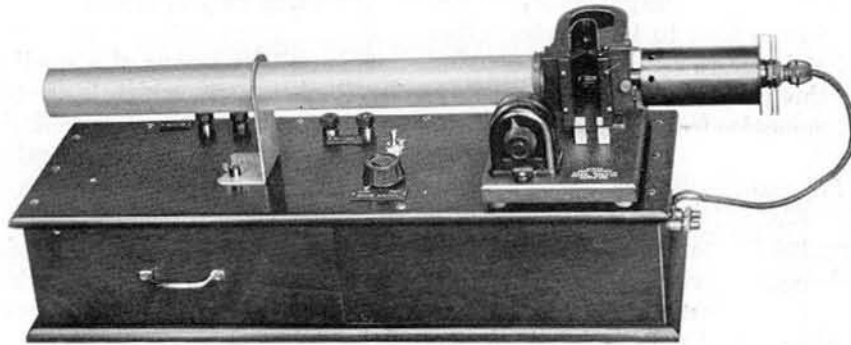
*Power Supply:* 110 volts, 60 cycle. About 40 watts required.

*Dimensions:* Table space required, 24 x 8 inches. Over all height, 14 inches.

*Weight:* 30 pounds without carrying case; 54 pounds with carrying case.

Type	Code Word	Price
338-L   .....	OFFER	\$250.00

VIBRATION GALVANOMETER MODEL



TYPE 338-G

BY omitting the rotating mirror box and substituting therefor a projection tube  $1\frac{3}{4}$  inches in diameter, terminating in a circular translucent screen, a vibration galvanometer is obtained which is very useful as a null-balance indicator for bridge measurements at 60 cycles or other low frequencies where telephone receivers are insufficiently sensitive, or at higher frequencies where a visual detector is desired.

*Galvanometer and String:* The galvanometer is sensitized by two permanent magnets which eliminate the need for direct-current excitation. The characteristics of the strings are described under TYPE 338 Accessories. Two TYPE 338-P1 Single String-Holders are supplied.

*Frequency Range:* 0 to 2000 cycles per second.

*Light Source:* Transformer operated from 110-volt, 60-cycle power supply, delivers

8 volts for lighting standard automobile headlight lamp.

*Mounting:* Whitewood carrying case supplied.

*Power Supply:* 110 volts, 60 cycle. About 40 watts required.

*Dimensions:* Table space required, 24 x 8 inches. Over all height, 12 inches.

*Weight:* 26 pounds without carrying case; 50 pounds with carrying case.

Type	Code Word	Price
338-G	OFTEN	\$175.00

TYPE 338-P ACCESSORIES AND REPLACEMENTS

THESE consist of the single and double string-holders, replacement strings, a transformer, and a rheostat. The two latter are especially useful for adapting the impedance of the string to the impedance of the circuit under measurement.

Various types of wires may serve as the string elements in the TYPE 338 String Oscillograph, but those supplied are wired with tungsten, 0.0004 inch in diameter. This material has been found to be most suitable for general work. The string has a resistance of about 45 ohms and is about 3 inches in length. When used in the standard galvanometer unit, the following data will give an indication of the sensitivity obtained.

The TYPE 338-P1 Single String-Holder contains one string mounted upon a metal rocker arm which in turn is attached to a bakelite strip. Two adjustment screws are provided. One varies the tension on the string and thereby adjusts its sensitivity and its natural period of vibration, while the other serves to displace the string as a whole across the light beam to center the image on the screen. Provision is made for damping the vibration of the string, if desired, by means of a drop of oil. By the choice of a proper grade of oil, the string may be rendered essentially aperiodic over a wide frequency range not too closely adjacent to the natural period of the string. This is, of course, highly important whenever a good reproduction of waveform is desired.

The string-holder is removable from the galvanometer, electrical contact being made through two springs on the galvanometer base. The string may be stretched to a natural frequency of from 3500 to 4000 cycles before breaking.

It is quite simple to replace broken strings in this unit by means of a small soldering iron. For this purpose, the TYPE 338-P3 String Replacement, which is stretched in a convenient mounting frame of coarse copper wire, may be ordered, or if desired, the string-holder may be returned to the factory for repair. The string will carry several times the aperiodic full-scale deflection current without danger of burnout. This is a desirable feature.

The TYPE 338-P2 Double String-Holder is designed to carry two electrically independent tungsten filaments, giving thus two simultaneous waveforms upon the observing screen. These two strings must vibrate in the same plane and, therefore, their images must be projected adjacent but not overlapping. One of the strings connects to the galvanometer in a manner identical with that of the single string-holder, while the other string terminates in two binding posts mounted on the holder unit, and requires an additional potentiometer (not supplied with string-holder) if a device to control the string sensitivity is needed.

Four adjustment screws are used to control individually the tensions on the two strings, their transverse separation, and the centering of both on the screen.

The use of two independent strings offers a wide range of application. It is somewhat more difficult to replace strings in this TYPE 338-P2 Double String-Holder, and it is recommended that holders be returned to the factory for restringing when necessary.



TYPE 338-P1

*Material:* Tungsten wire, 0.0004 inch diameter.

*Length:* 3½ inches.

*Resistance:* 45 ohms.

*Maximum Current:* Direct current, 200 milliamperes; alternating current, 300 milliamperes.

*Sensitivity:* With the string undamped and tuned to the fundamental of the applied alternating-current frequency, the following amounts of power are required to produce a waveform having an amplitude of one millimeter on the screen.

- At 60 cycles 0.001 microwatts
- At 250 cycles 0.025 microwatts
- At 500 cycles 0.144 microwatts
- At 1000 cycles 1.8 microwatts

The direct-current sensitivity of the same string when tuned to various frequencies is seen from the following data which gives the potential required to produce a steady deflection of one millimeter on the screen.

- At 60 cycles 5 millivolts
- At 250 cycles 65 millivolts
- At 500 cycles 300 millivolts
- At 1000 cycles 1300 millivolts



TYPE 338-P2

Type		Code Word	Price
338-P1	Single String-Holder .....	OCCUR	\$10.00
338-P2	Double String-Holder .....	OLIVE	35.00
338-P3	Single Replacement String in Mounting Frame .....	AGREE	1.00
585-N	Transformer (see page 45) .....		
340	Rheostat (see page 19) .....		
	Restringing TYPE 338-P1 (including string) .....		\$1.25
	Restringing TYPE 338-P2 (including strings) .....		3.00