FOR OFFICIAL USE ONLY

THEORY AND USE OF WAVEMETERS

SCR-60.
SCR-61.

Radio Pamphlet
No. 21

Signal Corps, U. S Army
5-21-18

THEORY AND USE OF WAVEMETERS

Various Methods of Using the Wavemeter as a Measuring Device—Description of SCR-60 and SCR-61 Wavemeters

The wavemeter is a piece of apparatus by means of which it is possible either to measure the length of electromagnetic waves generated by some outside source, or to emit waves of a known length. It may therefore be used to measure the inductance of a coil, the capacitance of a condenser, or the decrement of electromagnetic waves. It is thus a calibration instrument which finds use in both the field and the laboratory.

The principles upon which all wavemeters operate are the same. A general circuit diagram which might apply to any wavemeter is shown in Fig. 1. It consists of an oscillating circuit containing a condenser C and an inductance coil L, having a low ohmic resistance. By varying the capacitance in this oscillating circuit, its natural frequency can be brought into resonance with another oscillating circuit. When used as a measuring instrument, some sensitive device A is inserted in shunt or in series in the circuit, to indicate the voltage across the condenser or the current in the coil. In practice, this sensitive device may be a telephone receiver and a detector, a neon tube, a hot wire ammeter, or a galvanometer and thermo-couple. When the wavemeter is used as a generator of waves of known length, the device A is replaced by a buzzer and battery which excite damped oscillations in the wavemeter resonance circuit, at an audible wave train frequency.

The method of adjustment most commonly employed in using a wavemeter is to vary the natural period of the circuit by changing the capacitance of the meter and keeping the inductance constant. This affords a continuous variation of wave lengths between the limits of 0 and $2\pi\sqrt{LC}$. The condenser is therefore usually an air condenser, the capacitance of which may be varied from 0 to a certain maximum by means of a handle on the operating panel. To this handle is attached a pointer which moves over graduated scales,

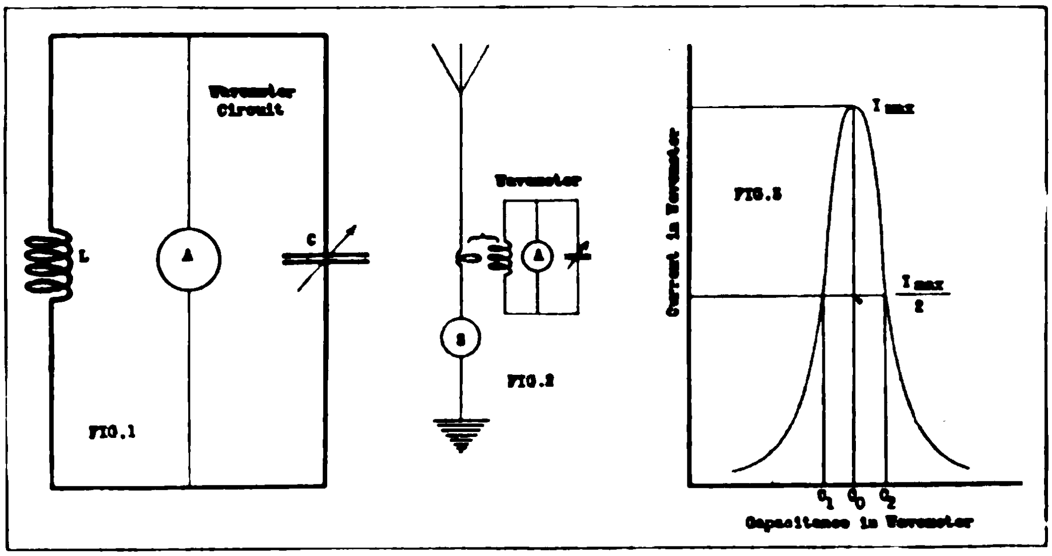

Fig. 1. General Wavemeter Circuit—Fig. 2. Use of Wavemeter—Fig. 3. Typical Resonance Curve.

reading directly in wave lengths or in conventional numbers corresponding to calibration curves. Several inductance coils having different numbers of turns are usually provided with a set, any one of which may be connected in the circuit. The apparatus may thus be made to cover a very wide range of wave lengths with reasonable accuracy.

Using the Wavemeter as a Measuring Instrument

To use a wavemeter for measuring the length of the waves sent out or received by a radio set S, Fig. 2, it is coupled to this set as loosely as its operation will permit so that there will be no appreciable reaction between the two circuits. The coupling is made inductively to the inductance coil of the wavemeter. The capacitance of the wavemeter condenser is then changed until a maximum indication is observed on the instrument A—maximum loudness of sound in the telephone, maximum brightness in the neon tube, maximum reading on the galvanometer, etc. At that time, the wavemeter circuit will be in resonance with the waves to be measured, and the length of waves will be indicated by the reading on the condenser dial scale.

Using the Wavemeter as a Generator

The wavemeter is used as a generator of electric oscillations when it is desired to calibrate another resonant circuit. It can be made to oscillate at any desired frequency by choosing the proper setting of the wavemeter condenser. For each setting of the wavemeter, the circuit to be calibrated is then tuned to the waves generated by the wavemeter, this establishing a calibration point for which the adjustments of the set under test are noted as corresponding to that specific wave length. This operation is repeated for various settings of the wavemeter condenser to obtain the desired number of calibration points.

Measuring Inductance and Capacitance

A rapid method of measuring the inductance of a coil or the capacitance of a condenser is to connect the coil or the condenser to a standard condenser or coil, respectively, of known constants, to make an oscillating circuit. This is then made to oscillate by means of a buzzer and its natural period is found by means of the wavemeter. Having determined the period, and knowing one of the constants, either L or C, of the circuit under test, the other constant C or L is easily computed by means of the formula

$$\lambda \text{ (wave length)} = 1884 \sqrt{LC}$$

where L is expressed in microhenrys, C in microfarads and λ in meters.

Measuring Decrement

If an oscillatory circuit of constant wave length is made to act upon a wavemeter circuit, the wave length of which is varied by changing the value of its capacitance, a so-called resonance curve may be plotted, showing the variation of wavemeter current with the natural frequency of the current in the wavemeter circuit. Such a curve will show a maxi-

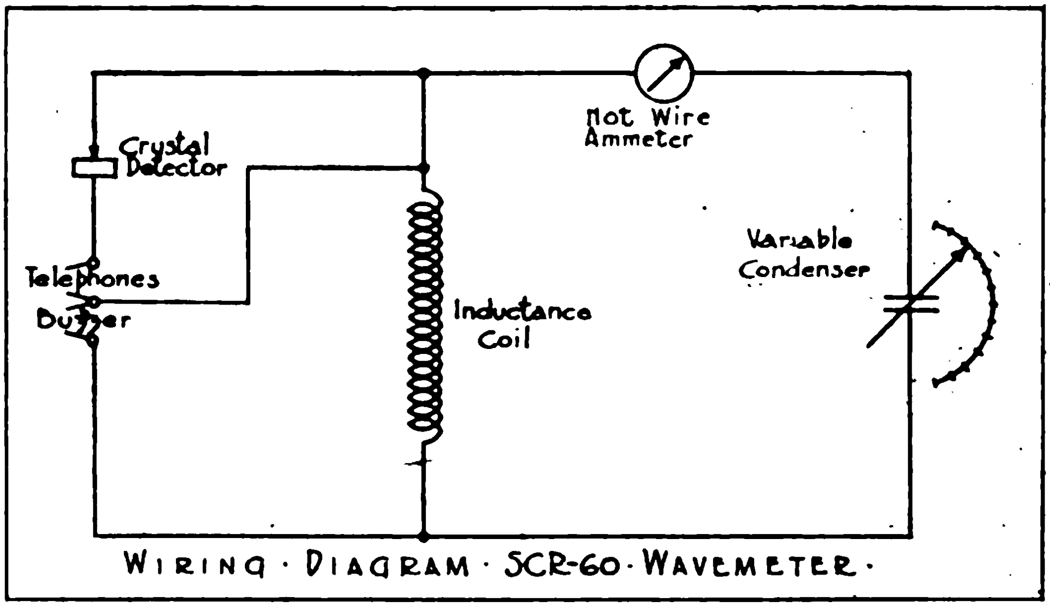

Fig. 4. Schematic Circuit Diagram of the SCR-60 Wavemeter.

mum current at that wavemeter frequency which is equal to the frequency of the circuit under test. The sharpness of the peak of this curve depends on the decrements d_1 and d_2 of the two circuits.

Instead of plotting current against frequency, current may be plotted against the corresponding condenser capacitance of the wavemeter, which is proportional to the frequency. If C_0, Fig. 3, represents the capacitance value of the condenser at resonance, and C_1 and C_2 the two values corresponding to current equal to one-half the resonance current, it can be shown that

$$d_1 + d_2 = \frac{\pi}{2} \cdot \frac{C_2 - C_1}{C_0},$$

or approximately that

$$d_1 + d_2 = \pi \frac{C_0 - C_1}{C_0}, \text{ or}$$

$$d_2 = \pi \frac{C_0 - C_1}{C_0} - d_1.$$

If the decrement d_1 of the wavemeter circuit is known, and C_1 and C_2 determined, it is possible to find the decrement, d_2, of the circuit under test.

As the decrement of a circuit is a function of its resistance, it is important that the adjustment of the wavemeter should not change its resistance. This is one of the reasons why the condenser is made variable rather than the inductance, since cutting turns of the inductance in or out of the circuit would change the resistance as well as the wave length.

SCR-60 Wavemeter

The SCR-60 wavemeter is a very simple set designed primarily for use with the SCR-67, SCR-68, SCR-79 and other radio apparatus, particularly airplane sets, in tuning them to emit the desired wave length. It is also extensively used for calibrating newly set up receiving stations. The wavemeter contains a single inductance coil and a variable condenser and hot wire ammeter in the local oscillating circuit, Fig. 4. In calibrating a set, the wavemeter is placed on the set box, or near it, and the condenser handle moved around until the maximum current reading is observed in the ammeter. The reading on the condenser scale then indicates the wave length of the set under calibration.

Fig. 5. Operating Panel of the SCR-60 Wavemeter.

The SCR-60 set is designed to measure wave lengths ranging from 200 to 700 meters. The SCR-60-A set is an identical wavemeter, except that the constants are changed to give a range of from 300 to 1000 meters. The SCR-60-B wavemeter is a similar set but is equipped with connectors for changing the constants of the wavemeter circuit to secure two ranges of measurement. One scale reads from 50 to 200 meters and the other from 200 to 700 meters. All three of the SCR-60 sets are equipped with crystal detectors, and with binding posts for connecting in telephones and a buzzer when it is desired to use these.

SCR-61 Field Type Wavemeter

A wiring diagram of the SCR-61 wavemeter, which is designed for ground work, is shown in Fig. 6. Three inductance coils are provided with the set and when any one of these is in use, it is clamped in the cover of the case containing the set, the clamp forming the electrical connection. The circuit from the coil in use to the remainder of the wavemeter circuit in the box, is made through the hinges of the cover. The condenser is varied by means of a handle which moves over scales reading directly in meters, there being a separate scale to correspond with each inductance coil. Each induction coil is designated by a letter stamped in the wood case, and a corresponding letter is printed on the dial opposite each scale. A telephone jack in series with a crystal detector is connected unilaterally when

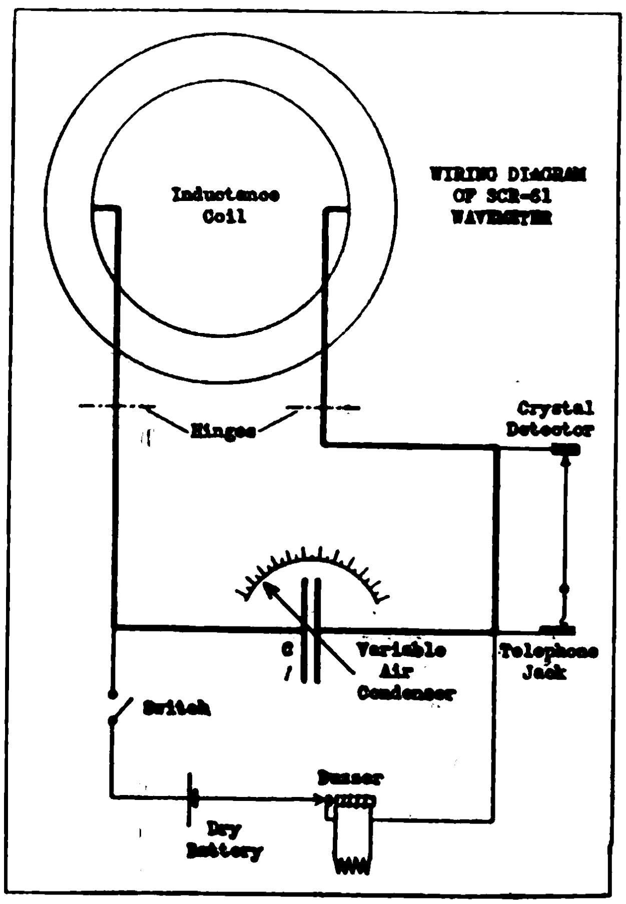

Fig. 6. Schematic Circuit Diagram of the SCR-61 Wavemeter.

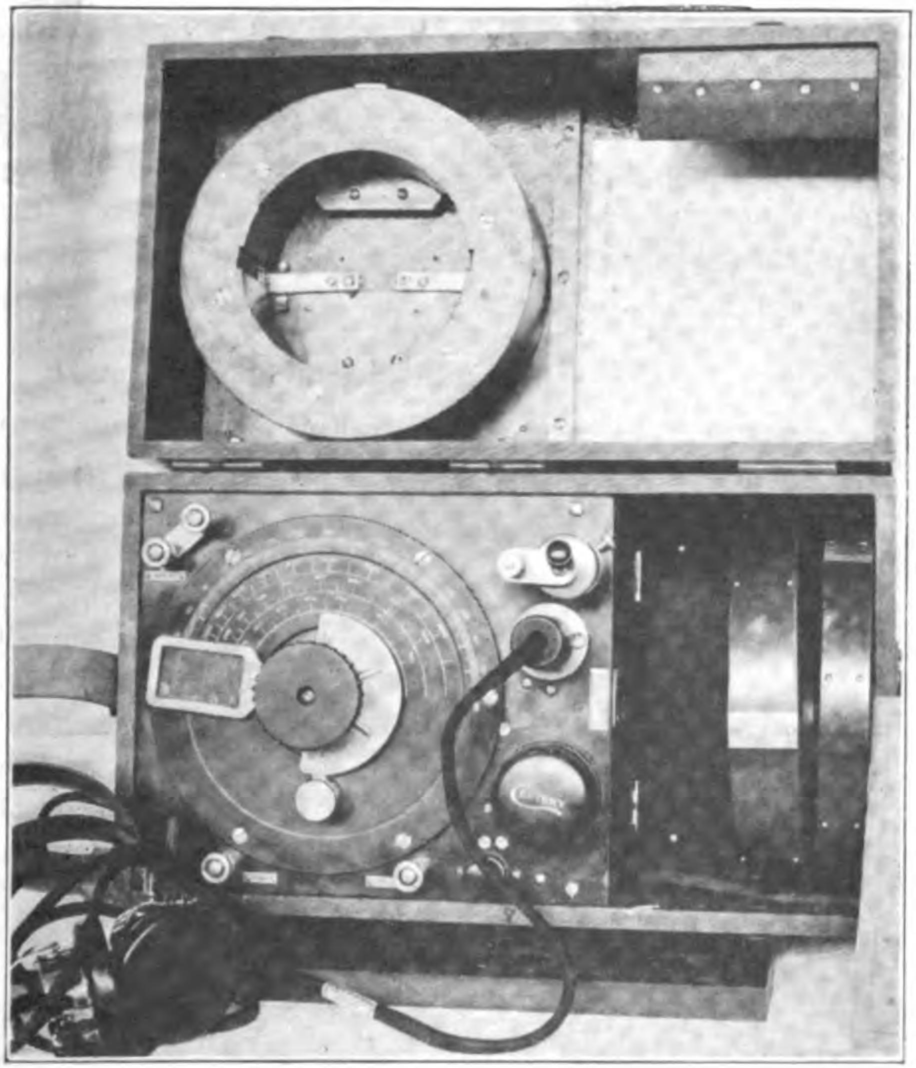

Fig. 7. Operating Panel of the SCR-61 Wavemeter and the Three Inductance Coils.

using the wavemeter for calibrating purposes. When using the set as a wave generator, the buzzer circuit through the wavemeter inductance coil is closed by a small switch to produce the necessary oscillations. The range of the set is from 150 to 2400 meters. It is intended for field use and is provided with a carrying strap.