

OPERATING INSTRUCTIONS  
FOR  
TYPE 419-A  
RECTIFIER-TYPE WAVE-  
METER

300-20 Megacycles, 1-15 Meters  
FORM 288D



**GENERAL RADIO COMPANY**  
CAMBRIDGE A, MASSACHUSETTS



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SECTION 1

PURPOSE OF THE INSTRUMENT

The instrument is intended primarily for general laboratory and service use where a rapid and fairly accurate measurement of frequency or wavelength is required. Besides the usual measurement of oscillators, radio transmitters and receivers, the instrument can be used to detect modulated signals and as an uncalibrated vacuum-tube voltmeter.

SECTION 2

PRINCIPLE OF OPERATION

The wavemeter comprises mainly a tuned circuit consisting of a variable condenser and plug-in coil and an indicator circuit. The purpose of the indicator circuit is to indicate the highest voltage in the tuned circuit as the wavemeter is coupled to a radio-frequency source and the condenser varied through resonance. When the frequency of an oscillator of low power or of a receiver is to be measured, the indicator would ordinarily give no reading. In such a case the wavemeter is set by observing the reaction of the tuned circuit on the apparatus being measured. For a discussion of resonance phenomena of tuned circuits, the user is referred to standard texts on radio communication.

SECTION 3

FUNCTIONAL CHARACTERISTICS

The complete diagram is shown in Figure 1. The natural frequency of the wavemeter is adjusted by plugging in one of the four coils and by means of the variable air condenser. To indicate the resonance point, a vacuum tube is used as rectifier in connection with a sensitive galvanometer. The indicator circuit is connected in series with a high resistance across the tuned circuit. The purpose of the resistance is to reduce the effect of changes in capacitance on the tuned cir-

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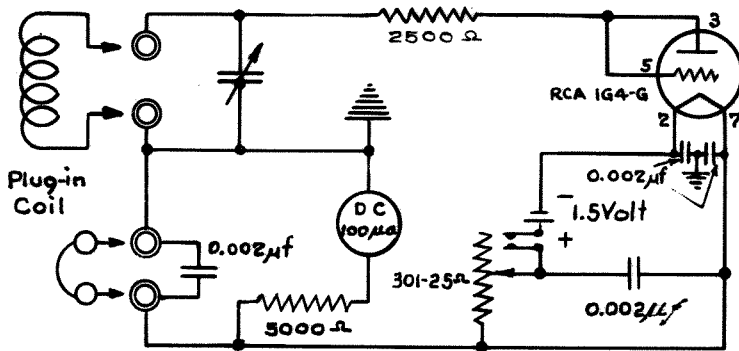


Figure 1.

Wiring diagram for the Type 419 Rectifier-Type Wavemeter

cuit when tubes are changed. A telephone connection is provided in parallel with the galvanometer. Modulated signals can be detected when a telephone is inserted at this point. The resistance in series with the galvanometer increases the impedance of the circuit in parallel with the telephones without materially reducing the sensitivity of the instrument.

Filament current is supplied by a dry cell included in the instrument case.

SECTION 4

CONSTRUCTIONAL DETAILS, QUANTITATIVE DATA,  
AND CIRCUIT CONSTANTS

Condenser The condenser is of the friction-drive type, with substantially straight-line frequency variation. The maximum capacitance is 70 micromicrofarads (similar in construction to Type 568).

Inductors Four inductors are provided for the range of from 1 to 15 meters. The plug arrangement is such as to insure the proper position of the coil when mounted in the instrument.

Rectifier One RCA 1G4-G type tube is used, operated

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as a two-element rectifier at a filament voltage of 1 to 1.2 volts (about 40 milliamperes).

Indicator The resonance indicator is a 100-micro-ampere direct-current meter.

Rheostat For filament control, the Type 301 25-ohm Rheostat is used.

Filament Switch A switch is provided in the filament circuit to turn off the filament current when readings are not being taken.

Resistances To separate the indicator circuit from the tuned circuit, a fish-line type 2500-ohm resistance is used. In series with the galvanometer a 5000-ohm resistance is used.

A-Battery A No. 6 dry cell is required for A-battery. The positive is connected to the rheostat, the negative to the filament of the tube.

Inductors A, 300 to 150 megacycles; B, 150 to 75 megacycles; C, 75 to 40 megacycles; D, 40 to 20 megacycles.

Calibration The calibration in frequency is given in a separate chart for each inductor. The calibration curve is drawn in red. The scale divisions are plotted at the bottom, and the frequency, in megacycles per second, is read on the left. To read wavelength, a conversion curve is provided. The wavelength corresponding to a given frequency is obtained when the black curve is used and the wavelength is read on the scale at the top of the chart.

Accuracy The design and method of calibrating these wavemeters are such that the user can depend on their frequency being within 1% of the value given in the calibration chart. Whether or not this accuracy is realized in practice depends on the method of measurement and the care with which the user makes the measurement. Some of the factors affecting the accuracy of wavemeter measurements are discussed in the next section.

### SECTION 5

#### OPERATING INSTRUCTIONS

General The four coils provided are contained in the lower part of the wooden case. To store the coils, Coil B is plugged in in Coil A.

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To use the wavemeter, the proper coil is inserted at the side of the instrument below the condenser. Care should be taken to push the coil all the way in. Access to the battery space is obtained by removing the five thumbscrews holding the panel in place. A No. 6 dry cell is required. A 230-type vacuum tube should be inserted in the socket provided. The felt-lined strip on the meter terminal should be adjusted over the top of the tube and tightened. This will prevent the tube from jarring loose from its socket.

The power output of the oscillator being measured will determine whether the absorption method can be used and readings made on the indicator instrument or whether the reaction method is required. The reaction method must be used for receivers.

The vacuum tube should be inserted in the socket whether it is used as an indicator or not, since the instrument is calibrated with the capacitance of the tube in circuit. While the resistance in series with the indicator is sufficient to eliminate the effect of differences between tube capacitance, the complete omission of the tube will affect the calibration.

The rheostat is turned on until the meter reads 20 to 40 micro-amperes. The coil must be inserted in order to obtain the meter reading. Filament current is drawn, however, unless the filament switch is turned to the OFF position. The switch should be turned to this position whenever the instrument is not in use.

Telephones should not be inserted when the meter is being used, since they detract somewhat from the sensitivity of the meter indication.

Absorption Method To measure the frequency of an oscillator or other radio-frequency source, the wavemeter is placed in the vicinity of the source in such position that sufficient energy is absorbed by the wavemeter to produce a readable deflection on the galvanometer at resonance.

The condenser of the wavemeter is varied until a maximum reading is observed on the galvanometer. The scale reading corresponding to this maximum is used in entering the calibration chart to determine the frequency or wavelength.

**CAUTION:** The wavemeter should not be coupled too closely to a powerful oscillator. Damage to the wavemeter may result if this precaution is not observed.

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Care should be taken to avoid the wavemeter "pulling" the oscillator frequency. With a very low power oscillator where close coupling is necessary to produce a readable deflection on the galvanometer, the oscillator may assume the wavemeter frequency as resonance is approached. When this occurs, the current maximum will appear to be very broad and the galvanometer reading will drop suddenly beyond resonance as the oscillator assumes the frequency of its own tuned circuit. If this happens, the oscillator has not sufficient power to permit the use of the absorption method, and some other method of resonance indication must be used.

Reaction Method - Oscillators If the oscillator being measured has not sufficient power to deflect the galvanometer, the reaction of the wavemeter on the oscillator can be used to determine the resonant reading. As the wavemeter is varied through resonance, a slight change in the plate current of the oscillator takes place. Provided the coupling between the oscillator and the wavemeter is small, so that the reaction on the oscillator is just perceptible, this method can be used with fairly accurate results. If the oscillator has a grid-current meter, the grid-current change can be used as a resonance indicator.

Receivers The receiver is set at the point where feeble oscillations start. This point can be detected in a telephone connected to the audio output of the receiver. When the wavemeter is coupled to the receiver, oscillations will cease as the condenser is varied through resonance. The coupling is then decreased until oscillations in the receiver are suppressed only in a very narrow range on the wavemeter. The accuracy of the setting will depend very greatly on the looseness of coupling at the final setting.

PRECAUTIONS: The exact resonant frequency of a wavemeter will be influenced slightly by objects in its immediate vicinity. If a metallic body is placed in the field of a wavemeter inductor, its effective inductance may be materially changed, and the calibration is no longer correct for the conditions under which it is used. Similarly the capacitance of nearby objects will affect the frequency of an oscillator. When a wavemeter is placed near an oscillator, both effects occur; the wavemeter changes the oscillator frequency and the presence of the oscillator affects the wavemeter. Whether or not these changes are large enough to affect appreciably the accuracy of the measurement depends on the conditions under which the measurement is made and may best be determined by experiment.

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Even when the capacitance effects just mentioned are negligible, another error may occur, due to "transformer action". The inductors of the oscillator and wavemeter act as the primary and secondary windings of a transformer, and the impedance of the wavemeter is reflected into the oscillating circuit. The magnitude of the reaction depends on the  $L/C$  ratios of the two circuits, and the amount of coupling between them. When the wavemeter is set to resonance, the impedance reflected into the oscillating circuit is purely resistive, and the change in oscillator frequency thus produced is negligible. If the wavemeter is not in resonance, the reflected impedance has a reactive component, and the frequency of the oscillator is materially changed.

As the capacitance of the wavemeter condenser is varied through resonance, the frequency changes as shown in Figure 2, where the zero axis represents the frequency of the oscillator before the wavemeter is coupled to it.

Detecting Modulated Signals The rheostat has to be turned on until the meter reads 20 to 40 micro-amperes. When the telephone is inserted in the jacks marked "TELEPHONE", modulated signals can be detected.

Use as Vacuum-Tube Voltmeter The instrument is used as described under Subdivision 2. The reading of the indicator instruments gives an idea of the voltage introduced. As it is almost impossible to build reliable instruments for frequencies above 100 megacycles, the readings of the indicator instrument are useful for comparative work.

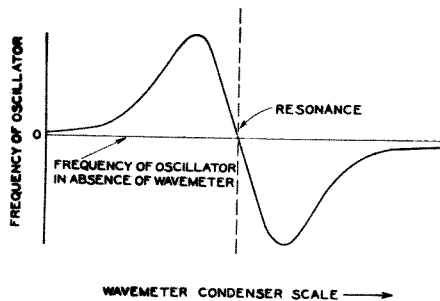


Figure 2.

