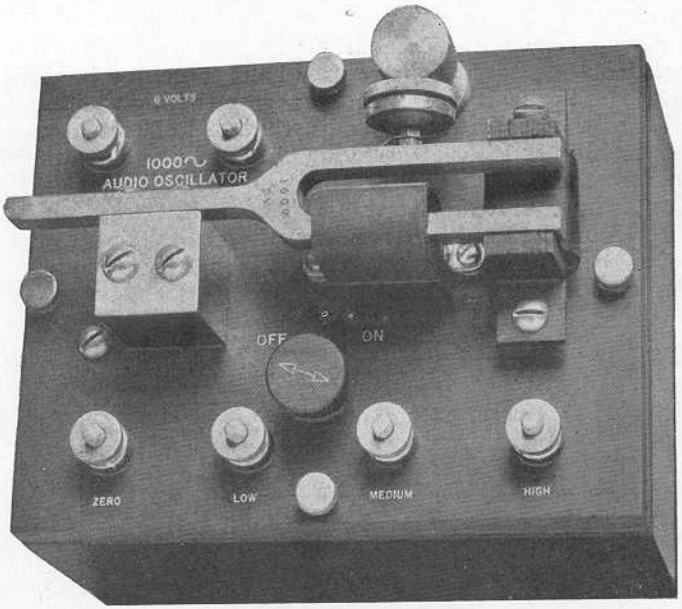
GENERAL RADIO COMPANY

MANUFACTURERS OF
HIGH GRADE RADIO LABORATORY APPARATUS
CAMBRIDGE, MASSACHUSETTS

BULLETIN 701 **FEBRUARY 1920**



AUDIO OSCILLATOR
Type 213

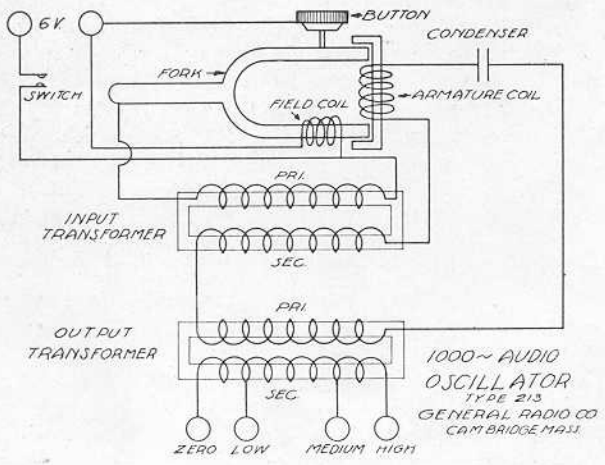
The precision of most alternating current bridge measurements is in no small measure dependent on the source of power supplied to the bridge. The wave form should be strictly free from harmonics. Where a balance is indicated by means of the null method with a telephone receiver, the presence of harmonics of even very small magnitude will prevent the accurate determination

of the balance point for the fundamental. The frequency must remain constant. The supply source should also be simple in its operation, rugged and reliable. It was to meet these requirements that the General Radio Co. Type 213 Audio Oscillator was designed.

The output of this oscillator is about 0.06 watt at 1000 cycles. External binding posts are so arranged that three output voltages may be obtained. The outputs obtainable with these three different connections are as follows:

Point	Voltage	Current
Low	0.5 volts	120 milliamperes
Medium	1.5 volts	40 milliamperes
High	5.0 volts	12 milliamperes

For some capacitance measurements it is desirable to use a high voltage. This increased voltage may be obtained by connecting an inductance and capacitance in series across the high voltage output terminals of the oscillator. By adjusting this circuit to resonance, voltages as high as 50 or 100 may be obtained by connecting output leads across the condenser. This instrument will operate satisfactorily on from four to eight volts. The input current is approximately 0.13 ampere. When running, the oscillator may be heard for a distance of approximately twenty-five feet, or may be made silent by enclosing in a sound-proof box.



The circuits of this oscillator are shown in the diagram. The closing of the switch places the field magnetizing coil directly across the battery. Also across the battery is the primary of the input transformer in series with the microphone button. The reso-

nance circuit consists of the secondary of the input transformer, the primary of the output transformer, the armature coil and the condenser. The output transformer secondary has three taps to permit the obtaining of three different output voltages. The use of the two transformers prevents the output wave from containing any direct current component. Each transformer core has a small air gap to prevent distortion of the wave form. Since, however, the magnetic circuits are all nearly closed iron paths there is very little outside field. This feature is particularly important where the oscillator is being used in close proximity to the bridge. The tuning fork insures that the frequency be kept constant and at 1000 cycles. The resonance circuit is carefully adjusted to this value. Since the oscillator is self-starting it may be located at a point distant from the bridge and operated by a switch placed at the bridge.

By the use of the field magnetizing coil on one tine of the vibrating fork, instead of relying on its permanent magnetism, the polarity and intensity of the magnetization of the fork with respect to the armature are permanently maintained.

Success or failure in the operation of a hummer, or audio oscillator, lies very largely in the microphone button. If the button heats so that the oscillator cannot be run indefinitely, if the adjustment of the button is not permanent, or if slight mechanical shocks change its operating characteristics the oscillator has little commercial value. A distortion of as small an amount as one five-hundredth of an inch from normal mica will destroy the perfect operation of the button. In order that the button may be insensitive to mechanical shocks and yet operate properly at 1000 cycles, use is made of its high inertia effect at the latter frequency. One side of the button is attached to the tuning fork by means of a short, flat spring. The other side, which has a projecting mounting post, is held in position by a specially designed self centering spring. This combination of springs enables the button to withstand severe shocks, yet it has sufficient inertia so that perfect operation is obtained. The adjustment of the button is permanent and needs no further attention after leaving our laboratory. This type of mounting, together with the fact that the electrical constants of the circuits have been adjusted to their optimum values, insures the continuous operation of the oscillator without heating.

The oscillator is mounted in a polished oak box and has an engraved bakelite panel. The exposed metal parts are finished in polished nickel. The control switch is easily accessible and is of the convenient lock button design.

Type 213 Audio Oscillator.....$32.00
Dimensions 6″ x 4¾″ x 5″. Weight 4½ lbs.
Code Word "AUGER"

The products of the General Radio Company cover a complete line of high frequency radio laboratory apparatus. Information and bulletins of special apparatus will be sent on request. Our line includes the following instruments:

Variable Air Condensers
Vernier Condensers
Standard Condensers
Decade Condensers
Variometers
Standards of Inductance
Standards of Resistance
Decade Resistance Boxes
Wavemeters
Decade Bridge
Capacity Bridge
Slide Wire Bridge
Audibility Meters
Hot Wire Ammeters
Galvanometers
Thermo-Couples
Telephone Transformer
Miscellaneous Apparatus

All prices in this catalogue are strictly net, subject to change without notice, F. O. B. Cambridge, Massachusetts. Cash should accompany orders from persons or firms with whom we have not already opened accounts. Unless otherwise instructed we shall use our own judgment regarding method of shipment.

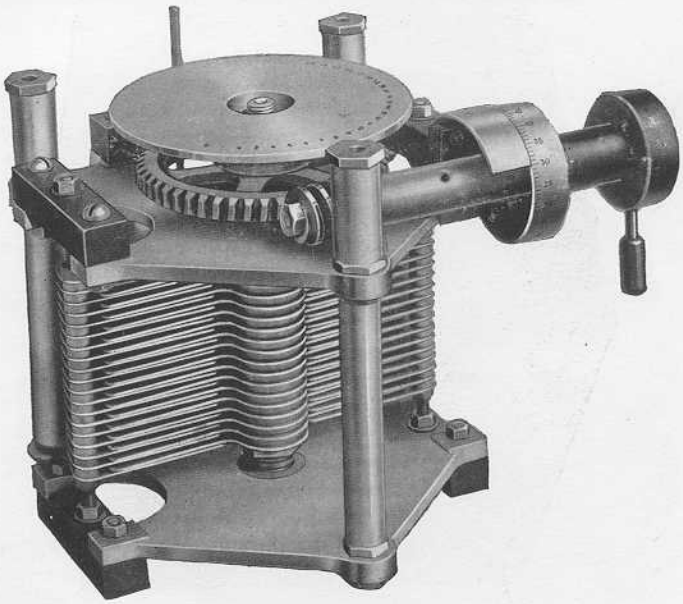
GENERAL RADIO COMPANY

MANUFACTURERS OF

HIGH GRADE RADIO LABORATORY APPARATUS

CAMBRIDGE, MASSACHUSETTS

BULLETIN 702 **AUGUST 1920**



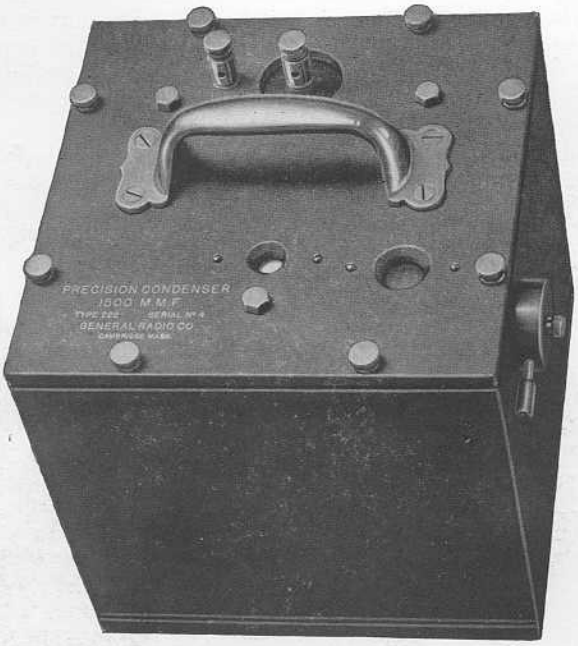
PRECISION CONDENSER
Type 222

Condensers used as standards and for precision measurements must have many features not usually found in ordinary laboratory condensers. For variable standards it is essential that the plates be sufficiently rigid and well spaced so that handling of the condenser will not cause a change in capacitance. It is not alone sufficient that the power factor be low but it is also important that the dielectric losses be substantially constant throughout the entire range of the condenser.

The General Radio Co. Type 222 Precision Condenser is not intended for use as an ordinary laboratory experimental condenser, but rather for those places where precision is essential. In its design the mechanical as well as the electrical features have received special attention. There are two sets of substantial semi-circular aluminum plates with wide spacing. The steel shaft runs in brass cone bearings,

which are positively locked in position. After assembly of the entire condenser the shaft is rotated for several hours to insure its perfect alignment and the wearing in of the bearings.

The rotary plates are turned by a worm and gear thus permitting of fine control. The worm is held by spring tension in position against the gear to prevent backlash due to wear. This is the same method used in accurate dividing engines. The rotation test referred to above includes the worm and gear so that they are well worn into place be-



fore the condenser is accepted. Attached to the main shaft is a scale, 180 degrees of which are divided into 25 equal parts. To the worm shaft is attached a second scale the circumference of which is divided into 100 equal parts. Since one complete turn of the worm shaft moves the main scale through one division the position of the rotary plates may be read directly to one part in 2500. As the divisions on the sub-scale are placed 1/16 inch apart it is possible to estimate easily to fifths.

Since there is only a small amount of solid dielectric used in the entire condenser, and since this dielectric is carefully selected, and is all placed in a weak electrostatic field, the power factor is very low, being approximately .01% at a capacitance of 1500 micromicrofarads. As the dielectric is not in the direct field of the rotary plates it is not influenced by their position. Thus the dielectric losses remain nearly constant throughout the entire range of the condenser. This is a particularly valuable feature in measurements of the properties of dielec-

trics. It permits the assumption that the condenser is equivalent to two parallel condensers, one of which is fixed and has all the losses and the other variable and has no losses. This condenser is adapted for use with potentials up to 1000 volts. With each condenser is a calibration table giving the calibration with an accuracy of 0.1% for 26 points.

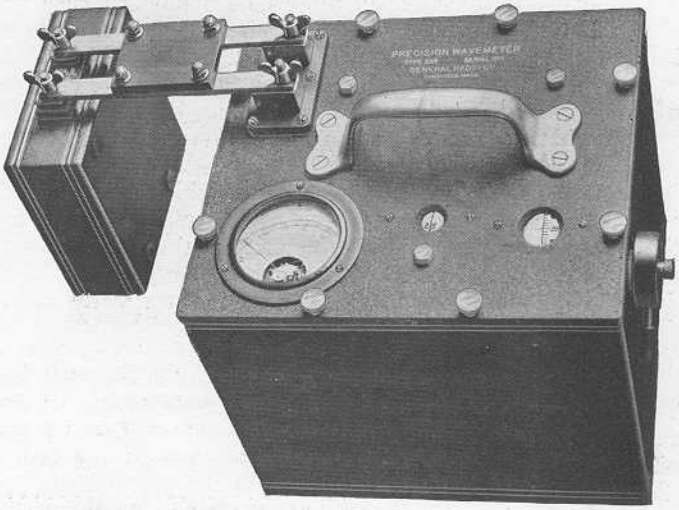
The case is of polished mahogany and is lined with a copper shield grounded to the rotary plates. A ¼ inch aluminum plate finished in a permanent crystalline black forms the condenser top. Other metal parts are finished in polished nickel. The top is fitted with a carrying handle. In order that the condenser may be kept free from dust the two scales are read through glass windows set into the aluminum top. A hard rubber rotating handle extends into the box and engages the worm shaft.

A substantial whitewood carrying case is furnished with each condenser. This case is fitted with a carrying handle and lock.

Type 222L Precision Condenser.....$90.00

Dimensions 8¼" x 8¾" x 9". Weight 16 lbs.

Code Word "COPAL"



PRECISION WAVEMETER
Type 224

Similar in general design to the Type 222 Precision Condenser is the Type 224 Precision Wavemeter. Accuracy and permanence of calibration are cardinal features of this instrument. To insure this accuracy under all conditions no extra circuits such as a buzzer or detector are incorporated in the wavemeter. There is but one circuit, the calibrated oscillating circuit, which consists of a condenser, inductance, and thermo-galvanometer. Such an arrangement requires a

minimum of leads and permits their resistance to be made negligibly small.

The condenser is the Type 222 Precision Condenser with a capacitance of 1500 micromicrofarads. The low losses of this condenser permit the obtaining of a very sharp resonance point. The scale arrangement, consisting of a primary scale and a sub-scale, is the same as used on the Precision Condenser. This arrangement permits a direct reading of capacitance to one part in 2500. When measuring the wavelength of a vacuum tube or other undamped oscillating circuit, it is possible to determine the resonance point to better than one half a division on the sub-scale which is equivalent in wavelength to one part in 10,000.

The inductance coils are wound with stranded wire with the separate strands insulated from each other. Five coils are furnished covering a range of from 75 meters to 24,000 meters with a good overlap between coils. These coils are so wound that the distributed capacitance and the dielectric losses are kept a minimum.

Resonance is indicated by means of a Weston Thermo-Galvanometer mounted in the top of the condenser case.

The condenser is mounted in a polished mahogany case similar to that of the Precision Condenser. The five inductance coils are also enclosed in mahogany boxes on which are mounted bakelite panels stating the coil ranges. The mounting posts of these coils are so arranged that they will fit on to the connecting bars in only one way, thus insuring that each coil always will be connected in the same manner in which it was calibrated.

The condenser case has a copper lining which is connected to the rotary plates of the condenser. The arrangement of connections is such that the rotary plates of the condenser, the shield, the thermo-galvanometer, and the outside of the inductance coil are on the low potential side of the circuit. This arrangement greatly reduces the possibility of disturbance by outside influences.

Wavelength data is furnished for 24 points with each of the five coils. Capacitance data is furnished for 26 points on the condenser.

A strongly built whitewood shipping case is furnished with each wavemeter. Separate compartments are provided for the condenser and coils. This case is fitted with a carrying handle and lock.

Type 224 Precision Wavemeter.....$220.00

Dimensions 18″ x 11″ x 11″. Weight 34 lbs.

Code Word "WAGER"

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GENERAL RADIO COMPANY

MANUFACTURERS OF

HIGH GRADE RADIO LABORATORY APPARATUS

CAMBRIDGE, MASSACHUSETTS

BULLETIN 703 **NOVEMBER 1920**

AUDIO OSCILLATOR
Type 213

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ance point for the fundamental. The frequency must remain constant. The supply source should also be simple in its operation, rugged and reliable. It was to meet these requirements that the General Radio Co. Type 213 Audio Oscillator was designed.

The output of this oscillator is about 0.06 watt at 1000 cycles. External binding posts are so arranged that three output voltages may be obtained. The outputs obtainable with these three different connections are as follows:

Point	Voltage	Current
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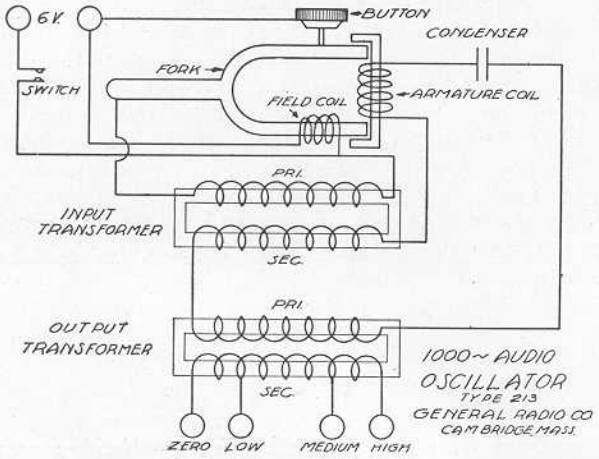
For some capacitance measurements it is desirable to use a high voltage. This increased voltage may be obtained by connecting an inductance and capacitance in series across the high voltage output terminals of the oscillator. By adjusting this circuit to resonance, voltages as high as 50 or 100 may be obtained by connecting output leads across the condenser. This instrument will operate satisfactorily on from four to eight volts. The input current is approximately 0.13 ampere. When running, the oscillator may be heard for a distance of approximately twenty-five feet, or may be made silent by enclosing in a sound-proof box.



The circuits of this oscillator are shown in the diagram. The closing of the switch places the field magnetizing coil directly across the battery. Also across the battery is the primary of the input transformer in series with the microphone button. The resonance circuit

consists of the secondary of the input transformer, the primary of the output transformer, the armature coil and the condenser. The output transformer secondary has three taps to permit the obtaining of three different output voltages. The use of the two transformers prevents the output wave from containing any direct current component. Each transformer core has a small air gap to prevent distortion of the wave form. Since, however, the magnetic circuits are all nearly closed iron paths there is very little outside field. This feature is particularly important where the oscillator is being used in close proximity to the bridge. The tuning fork insures that the frequency be kept constant and at 1000 cycles. The resonance circuit is carefully adjusted to this value. Since the oscillator is self-starting it may be located at a point distant from the bridge and operated by a switch placed at the bridge.

By the use of the field magnetizing coil on one tine of the vibrating fork, instead of relying on its permanent magnetism, the polarity and intensity of the magnetization of the fork with respect to the armature are permanently maintained.

Success or failure in the operation of a hummer, or audio oscillator, lies very largely in the microphone button. If the button heats so that the oscillator cannot be run indefinitely, if the adjustment of the button is not permanent, or if slight mechanical shocks change its operating characteristics the oscillator has little commercial value. A distortion of as small an amount as one five-hundredth of an inch from normal mica will destroy the perfect operation of the button. In order that the button may be insensitive to mechanical shocks and yet operate properly at 1000 cycles, use is made of its high inertia effect at the latter frequency. One side of the button is attached to the tuning fork by means of a short, flat spring. The other side, which has a projecting mounting post, is held in position by a specially designed self centering spring. This combination of springs enables the button to withstand severe shocks, yet it has sufficient inertia so that perfect operation is obtained. The adjustment of the button is permanent and needs no further attention after leaving our laboratory. This type of mounting, together with the fact that the electrical constants of the circuits have been adjusted to their optimum values, insures the continuous operation of the oscillator without heating.

It should, of course, be understood that this oscillator is not intended to displace the larger types of oscillators used where several watts of output are required. It is intended rather for general laboratory use where power of good waveform is desired for a single bridge. As the pureness of waveform is dependent on the load on the oscillator, whenever a pure waveform is essential the oscillator should not be overloaded. This oscillator is adapted for the usual alternating current measurements of inductance and capacitance.

The oscillator is mounted in a polished oak box and has an engraved bakelite panel. The exposed metal parts are finished in polished nickel. The control switch is easily accessible and is of the convenient lock button design.

Type 213 Audio Oscillator.....$32.00

Dimensions 6″ x 4¾″ x 5″. Weight 4½ lbs.

Code Word "AUGER."

WESTERN ELECTRIC HEAD PHONES
Type 1002-A

Where a sensitive high resistance telephone receiver is used to indicate a bridge balance by the null method we recommend the use of the Western Electric Type 1002-A head phones. This is a double head set complete with adjustable head-band. The resistance per pair is 2200 ohms. These receivers are light, rugged and extremely sensitive. In addition to being adapted to bridge work they are used very extensively in radio receiving sets.

Price complete with cord.....$15.00

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All prices in this catalogue are strictly net, subject to change without notice, F. O. B. Cambridge, Massachusetts. Cash should accompany orders from persons or firms with whom we have not already opened accounts. Unless otherwise instructed we shall use our own judgment regarding method of shipment.

[This Bulletin replaces Bulletin 701]

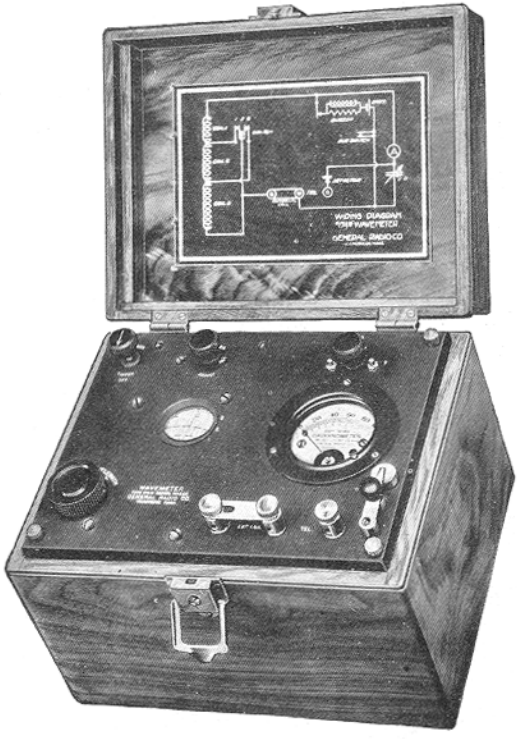
GENERAL RADIO COMPANY

MANUFACTURERS OF

ELECTRICAL AND RADIO LABORATORY APPARATUS

CAMBRIDGE 39, MASSACHUSETTS

BULLETIN 708 MAY, 1923



TYPE 174

DIRECT READING WAVEMETER

The Type 174 wavemeter is designed for general use in commercial and experimental radio stations. Its equipment is such that it is adapted for use with receiving or transmitting sets, employing either damped or undamped waves. Its self-contained, direct-reading features make this instrument particularly valuable for commercial work.

A hot wire galvanometer is used for indicating resonance of transmitted signals of average intensity, while for weak signals a crystal detector and binding posts for telephones are provided. For producing damped oscillations of known wavelengths, the wavemeter is equipped with a high frequency buzzer operating on a battery mounted within the wavemeter case. The oscillating circuit consists of three coils with a selector switch and a variable air condenser. This combination gives a wavelength range of 130 to 3000 meters. The inductance coils are bank-wound in order to keep the distributed capacity a minimum. The condenser is our low loss Type 239, equipped with slow-motion gear.

Particular care has been given to the mechanical construction and to the appearance of this instrument. All of the equipment is mounted on a hard rubber panel and enclosed in a polished walnut carrying case fitted with lock and key. The metal parts are finished in polished nickel.

OPERATION

The dial on which are drawn the three wavelength scales corresponding to the three inductance coils is mounted directly above the variable condenser and is fastened to the rotor plate shaft. The scales are indicated by the numbers 1, 2 and 3 engraved on the panel. Above the galvanometer is a switch engraved RANGE, with points numbered 1, 2 and 3. These three points correspond respectively to the three wavelength scales. Thus, when the wavemeter is set say at 360 meters, Scale 1 is used and the range switch set on Point 1. In addition to the three wavelength scales, a scale divided into one hundred equal divisions is provided. This scale is simply placed for reference and is convenient in making certain measurements.

TRANSMITTING SETS

In determining the wavelength of a transmitting set, the range switch should be set on the point covering the wavelength scale within which the transmitted wavelength should fall. The wavemeter should then be brought near the tuning inductance or the antenna or ground lead of the transmitter. By turning the knurled knob marked INCREASE WAVELENGTH, the variable condenser will be rotated, varying the wavelength of the wavemeter. At resonance—that is, the point where the wavelength of the wavemeter is the same as that of the transmitter—the maximum amount of energy will be transferred from the transmitting set to the wavemeter. This point is indicated by a maximum deflection of the hot wire galvanometer. Care, however, should be taken that the wavemeter is not too near a powerful transmitter because an excess amount of energy may be transferred to the wavemeter, causing the galvanometer to burn out. It will be found that with a sharply tuned transmitter, particularly when using

vacuum tubes, that the resonance point is very sharp. The condenser must be rotated slowly, as the galvanometer needle will swing from zero to nearly full scale and back again over a very small range of wavelengths. If the condenser is rotated too rapidly, the resonance point will be passed through without being noted. In the case of a buzzer or transmitter of small output, sufficient energy may not be radiated to operate the galvanometer. In this case, a pair of telephones should be connected to the binding posts marked TEL. Resonance will then be indicated by maximum intensity of signal in the telephones.

RECEIVING SETS

Two methods of determining the wavelength of a receiving set may be employed. The first, the reaction method, is applicable only to a vacuum tube receiving set, and then only when the set is oscillating. The wavemeter should be brought near the tuning inductance of the receiving set. By turning the condenser of the wavemeter a sharp click will be heard in the head phones of the receiving set at the point where the condenser passes through the resonance point. The wavelength would then be read on the proper scale. It is usually necessary to have the wavemeter quite close to the receiving set. As the axis of the coils in the wavemeter is parallel to the panel, and extends from front to rear of the case directly beneath the galvanometer, best results are usually obtained by placing the right-hand edge of the wavemeter parallel to the tuning coil of the receiving set.

Where it is desired to set an inductively-coupled receiving set at a definite wavelength, the wavemeter should be set at that wavelength and the antenna circuit of the receiving set opened. The secondary of the receiving set should be adjusted either by means of the inductance or condenser until the reaction click is heard in the head phones of the receiving set. The wavemeter is then removed and the antenna circuit reconnected. The antenna circuit should then be varied until a click is again heard in the head phones. This will indicate that the primary and secondary circuits of the receiving set are both adjusted to the same value and to the value set on the wavemeter. This method requires, of course, that the set be oscillating during adjustment.

Where a single circuit receiving set is used, the antenna and ground connections should be left on. The tuning condenser is varied until the reaction click is heard in the telephone receivers. As with the inductively-coupled receiving set, the vacuum tube must be oscillating while the wavelength adjustments are being made.

A much quicker but slightly less accurate way to adjust the receiver is by means of the buzzer on the wavemeter. The wavemeter is set at the desired wavelength and the buzzer turned on by means of the buzzer switch. The receiving set should then be adjusted until the maximum intensity of buzzer signal is heard in the head phones. This method of adjustment is similar to tuning to an incoming signal.

GENERAL

Because of the sensitive type of buzzer used, it may be found that on turning the buzzer switch no sound can be heard. The buzzer adjusting screw should be turned to the right or left until the buzzer starts to operate. If the buzzer will not operate, make certain that the battery is in good condition. When a wavemeter is shipped, no battery is placed in the wavemeter, but one is shipped separately. This method is used to prevent damage to the wavemeter in case it should remain unused for a long time. Dry cells kept for a long time in an inverted or horizontal position will deteriorate and leak; the wavemeter should, accordingly, always be stored so that the cover is on top, thus keeping the battery in an upright position.

The diagram mounted in the cover should be studied carefully in order to understand the wavemeter circuits. The four panel thumbscrews should be removed and the panel lifted from the case. The inside of the wavemeter should be examined to become familiar with its mechanical operation, but under no circumstances should adjustments be attempted, as they will affect the calibration. The buzzer battery should be put in place before replacing the panel. It will be noted that provision has been made on the panel for an external coil. This arrangement is to enable an additional coil to be used for special work. Under normal conditions the short circuit bar between the two binding posts marked EXT COIL should not be removed. This is true even when the telephone receivers are connected to the telephone binding posts. This bar is removed only when an external coil is used.

Type 174 Direct Reading Wavemeter..... $68.00
Code Word: "WITTY."

Dimensions 9″ x 7″ x 6″. Weight 6¾ lbs.

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GENERAL RADIO COMPANY

MANUFACTURERS OF

ELECTRICAL AND RADIO LABORATORY APPARATUS

CAMBRIDGE, MASSACHUSETTS

BULLETIN 710 **OCTOBER 1923**

Type 305
COMBINATION WAVEMETER AND FILTER

With the large number of broadcasting stations operating there are few locations where it is not often desirable to eliminate some interfering station. Unless the wave length separation is large this elimination can seldom be obtained by the usual tuning methods. Oftentimes there is general interference which it is desired to reduce. These results may be accomplished by the use of the Type 305 Radio Filter. This instrument consists of a tuned circuit inductively coupled to a coil placed in the antenna circuit. To use this filter it is necessary only to connect the antenna and ground wires to two binding posts on the input side of the filter and the receiving set to two binding posts on the output side. All necessary changes in connections are made by a single selector switch. As this switch is provided with an off position the filter may be left permanently connected and used only when desired. This selector switch enables the filter to be used as either a rejector or acceptor without the necessity of changing a single external connection. The condenser is a special model of our low loss, gear controlled Type 247 with plates shaped so as to give a nearly uniform wave length scale. The coils are wound

with sufficiently large wire to give the circuit a low decrement, and the number of turns of the antenna coil are controlled by the selector switch. One of the valuable features of the instrument is the wave length scale marked directly on the condenser dial. This scale, calibrated to within 2%, not only aids in the setting of the filter, but also enables the filter to be used as a wavemeter. The scale is calibrated from 150 to 500 meters, which is the working range of the filter. The entire equipment is mounted on a bakelite panel and enclosed in a polished walnut cabinet. The metal parts are finished in polished nickel.

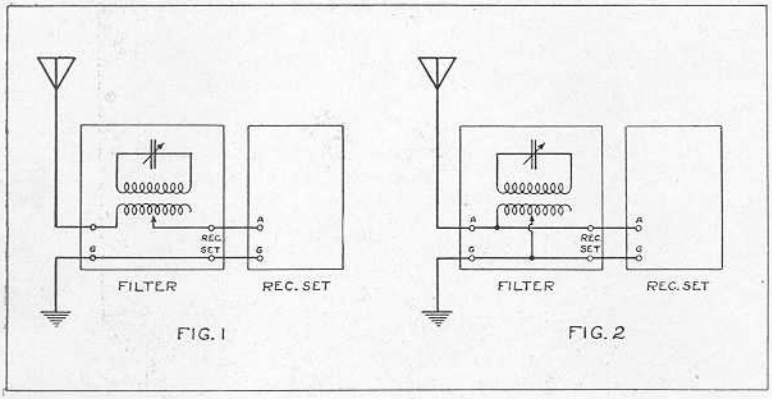


FIG. 1 FIG. 2

OPERATION

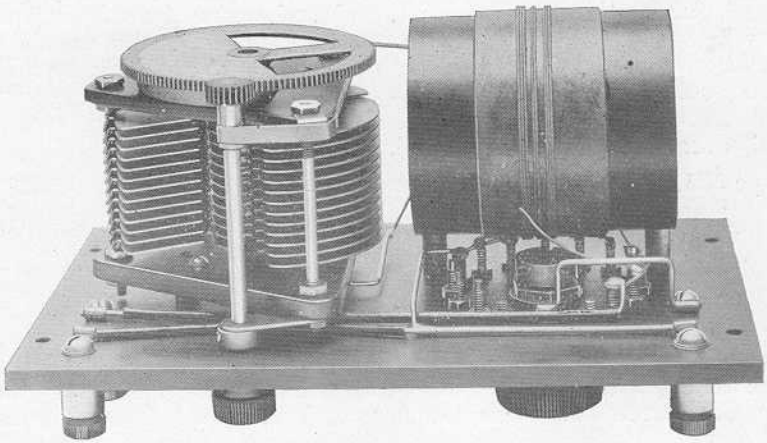
The filter can be used with any antenna connected receiving set to improve the selectivity; the improvement being more noticeable when used with the single circuit type than with the inductively coupled type of receiver. When used with a crystal receiver the operation of the filter is quite simple, but some practice is necessary to get the best results when using it with a regenerative tube set, especially when the Parallel Filter is used. The external connections are the same for all uses of the filter. The antenna is connected to the binding post marked A and the ground to G. The binding posts of the receiving set that ordinarily would be connected to antenna and ground should be connected to the two filter binding posts marked REC. SET. When the white indicator line of the filter selector switch is set opposite the contact marked O the filter is disconnected and the receiving set may be used just as if the filter were not present.

1. THE SERIES FILTER. When the selector switch is set opposite the contacts marked 8 or 5 of the SER side, the connections are as shown in Fig. 1. It will be seen that the filter is connected in series with the antenna. If the wave length scale of the filter condenser is then set at some point such as 360 meters any incoming signal of this wave length will be prevented from reaching the receiving set. This is due to the counter-electromotive force set up in the

resonance circuit of the filter. The effectiveness of the filter in cutting out a station depends on the sharpness of the tuning of the station. For this reason spark stations cannot be eliminated effectively by the series filter. The parallel filter must be used for such cases.

When it is desired to eliminate a single broadcasting or other continuous wave station set the filter switch at O and tune the receiving set until the undesirable station is received with maximum intensity. Then set the filter switch on point 8 of the SER (series) side and turn the wave length scale slowly until the station disappears and comes back again. Rotate the dial back and forth, using the vernier knob, until the point of minimum intensity is found. Leaving the filter set at this point the receiving set may be re-tuned to whatever wave length is desired. If this wave length is more than 10 meters away from that of the interfering station usually no interference will be experienced.

If the interfering station signal intensity is small compared with that of the desired station the filter switch may be set on point 5 instead of 8. These numbers refer to turns on the coupling coil. The more turns used the more effective the filtering action, but a broader neutralized band is obtained.



When cutting out an interfering station by the series connection, there will be no reduction of signals on wave lengths differing by a few meters from the filter setting. The wave length of the interfering station may be read from the setting of the filter condenser dial.

2. THE PARALLEL FILTER. When the selector switch is set on the PAR (parallel) side the connections are as shown in Fig. 2. It will be seen that the filter is connected in parallel with the receiving set and forms a short circuit between the antenna and ground. Incoming signals of the same wave length as that for which the filter is set build up a voltage across the terminals of the filter which is

impressed on the input of the receiver. Signals of all other wave lengths are not in resonance with the filter and pass to the ground as if short circuited. It will thus be seen that when set for the parallel position the filter will permit only signals of one wave length to reach the receiving set. These signals, however, will be reduced somewhat in strength, due to unavoidable losses in the filter circuit, so that it is possible to use the parallel connection only with signals of at least moderate intensity.

When it is desired to receive from a single station only set the filter switch at O and tune the receiving set so as to receive the desired station at maximum intensity. Set the filter switch on 5 of the PAR side and carefully turn the wave length dial until the signals are again heard with maximum intensity. Further improvement will be obtained by re-tuning the receiving set and making any further readjustment necessary on the filter. The best results will be obtained using the parallel connection after experience is obtained in the retuning adjustments. The tuning of the filter is very critical and care must be taken in making settings.

The parallel connection will be found particularly helpful when it is desired to listen to a broadcast program without the annoyance of radio telegraph interference.

3. USE AS WAVEMETER. Wave lengths of received signals may be measured directly with an accuracy of 2%. To do this set the filter switch on O and tune the receiving set to the desired station; then set the filter switch on 5 of the SER side and turn the wave length scale until the signal disappears. The reading on the wave length dial is that of the incoming signal.

Type 305. Combination Wavemeter and Filter $25.00
Dimensions 8″x9¼″x7½″. Weight 7 lbs.
Code Word: "FAIRY."

The products of the General Radio Company include not only those listed in this bulletin, but also radio and electrical laboratory apparatus. Information and bulletins of special apparatus will be sent on request. These instruments include: Low Loss Variable Air Condensers, Precision Condenser, Vernier Condenser, Decade Condenser, Variometers, Standards of Inductance, Standards of Resistance, Decade Resistance Boxes, Impedance Bridge, Capacity Bridge, Slide Wire Bridge, Audibility Meter, Wavemeters, Ratio Arm Box, Galvanometer Shunt, Hot Wire Ammeters, Recorders, Amplifiers and Miscellaneous Apparatus.

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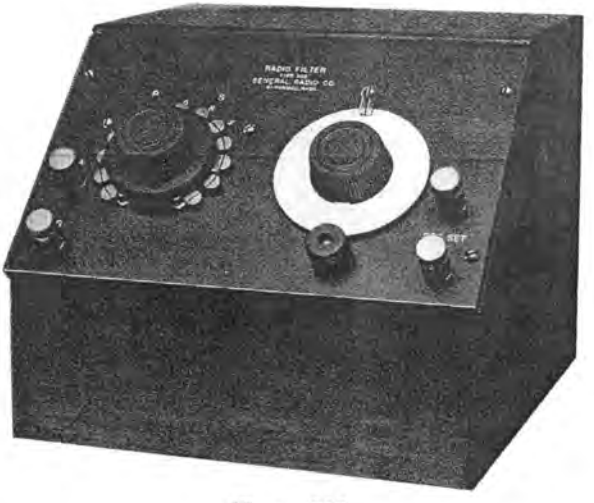
GENERAL RADIO COMPANY

MANUFACTURERS OF

ELECTRICAL AND RADIO LABORATORY APPARATUS

CAMBRIDGE, MASSACHUSETTS

BULLETIN 711 **JANUARY 1925**



Type 305

COMBINATION WAVEMETER AND FILTER

With the large number of broadcasting stations operating there are few locations where it is not often desirable to eliminate some interfering station. Unless the wave length separation is large this elimination can seldom be obtained by the usual tuning methods. Oftentimes there is general interference which it is desired to reduce. These results may be accomplished by the use of the Type 305 Radio Filter. This instrument consists of a tuned circuit inductively coupled to a coil placed in the antenna circuit. To use this filter it is necessary only to connect the antenna and ground wires to two binding posts on the input side of the filter and the receiving set to two binding posts on the output side. All necessary changes in connections are made by a single selector switch. As this switch is provided with an off position the filter may be left permanently connected and used only when desired. This selector switch enables the filter to be used as either a rejector or acceptor without the necessity of changing a single external connection. The condenser is a special model of our low loss, gear controlled Type 247 with plates shaped so as to give a nearly uniform wave length scale. The coils are wound

with sufficiently large wire to give the circuit a low decrement, and the number of turns of the antenna coil are controlled by the selector switch. One of the valuable features of the instrument is the wave length scale marked directly on the condenser dial. This scale, calibrated to within 2%, not only aids in the setting of the filter, but also enables the filter to be used as a wavemeter. The scale is calibrated from 150 to 500 meters, which is the working range of the filter. The entire equipment is mounted on a bakelite panel and enclosed in a polished walnut cabinet. The metal parts are finished in polished nickel.

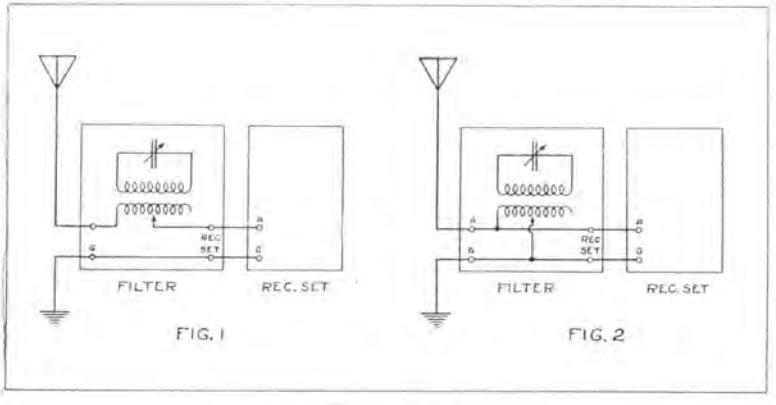


FIG. 1 FIG. 2

OPERATION

The filter can be used with any antenna connected receiving set to improve the selectivity; the improvement being more noticeable when used with the single circuit type than with the inductively coupled type of receiver. When used with a crystal receiver the operation of the filter is quite simple, but some practice is necessary to get the best results when using it with a regenerative tube set, especially when the Parallel Filter is used. The external connections are the same for all uses of the filter. The antenna is connected to the binding post marked A and the ground to G. The binding posts of the receiving set that ordinarily would be connected to antenna and ground should be connected to the two filter binding posts marked REC. SET. When the white indicator line of the filter selector switch is set opposite the contact marked O the filter is disconnected and the receiving set may be used just as if the filter were not present.

1. THE SERIES FILTER. When the selector switch is set opposite the contacts marked 8 or 5 of the SER side, the connections are as shown in Fig. 1. It will be seen that the filter is connected in series with the antenna. If the wave length scale of the filter condenser is then set at some point such as 360 meters any incoming signal of this wave length will be prevented from reaching the receiving set. This is due to the counter-electromotive force set up in the

resonance circuit of the filter. The effectiveness of the filter in cutting out a station depends on the sharpness of the tuning of the station. For this reason spark stations cannot be eliminated effectively by the series filter. The parallel filter must be used for such cases.

When it is desired to eliminate a single broadcasting or other continuous wave station set the filter switch at 0 and tune the receiving set until the undesired station is received with maximum intensity. Then set the filter switch on point 8 of the SER (series) side and turn the wave length scale slowly until the station disappears and comes back again. Rotate the dial back and forth, using the vernier knob, until the point of minimum intensity is found. Leaving the filter set at this point the receiving set may be re-tuned to whatever wave length is desired. If this wave length is more than 10 meters away from that of the interfering station usually no interference will be experienced.

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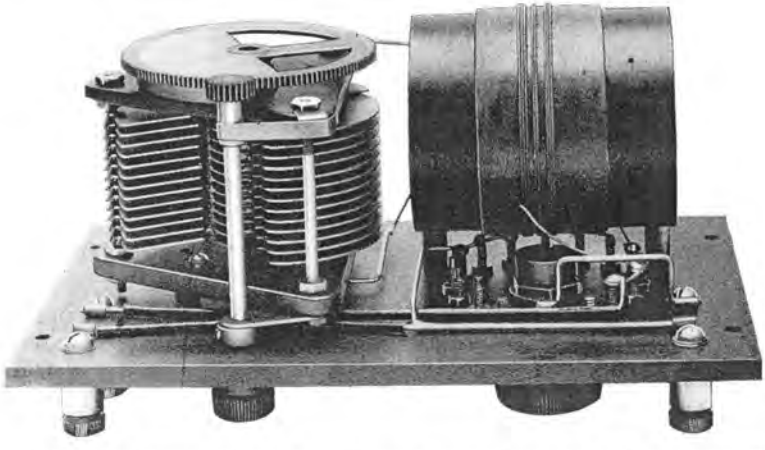

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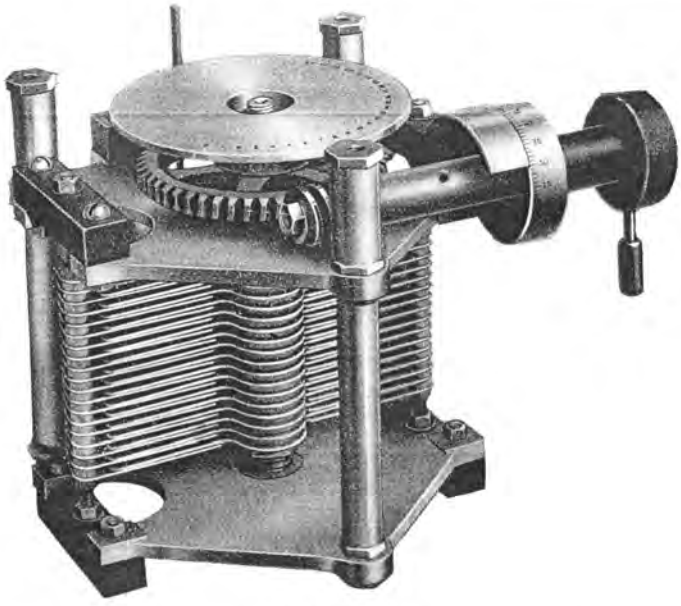
GENERAL RADIO COMPANY

MANUFACTURERS OF

ELECTRICAL AND RADIO LABORATORY APPARATUS

CAMBRIDGE, MASSACHUSETTS

BULLETIN 741 NOVEMBER 1923



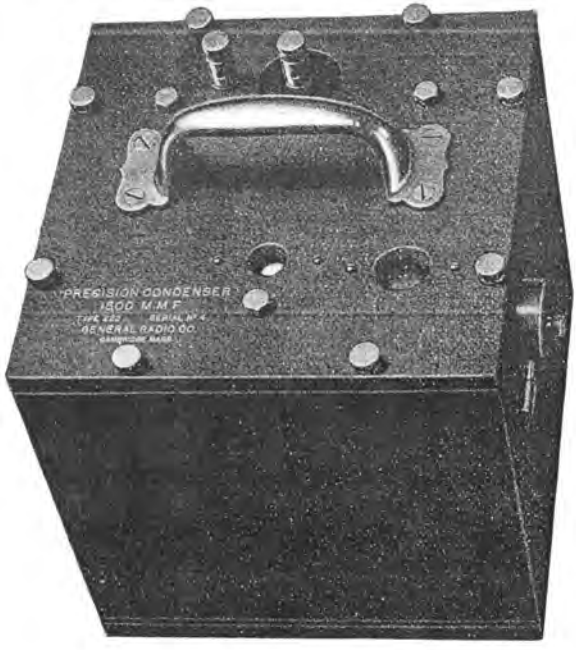
Type 222
PRECISION CONDENSER

Condensers used as standards and for precision measurements must have many features not usually found in ordinary laboratory condensers. For variable standards it is essential that the plates be sufficiently rigid and well spaced so that handling the condenser will not cause a change in capacitance. It is not alone sufficient that the power factor be low, but it is also important that the dielectric losses be substantially constant throughout the entire range of the condenser.

The General Radio Co. Type 222 Precision Condenser is intended for those places where precision is essential, rather than for use as an ordinary laboratory experimental condenser. In its design, the mechanical as well as the electrical features have received special attention.

MECHANICAL. The plates are of heavy aluminum, widely separated by accurately turned spacers, and firmly clamped between substantial cast metal end-plates. A steel shaft, carrying the rotating

plates, turns in cone-shaped bronze bearings. The adjustment is locked after the condenser has been subjected to a rotation test to insure the proper wearing in of the bearings.



The rotary plates are turned by a worm and gear, thus permitting fine control. The worm is held by spring tension in position against the gear to prevent backlash. This is the same method used in accurate dividing engines. The rotation mentioned above includes the worm and gear so that they are well worn into place before the condenser passes inspection.

ELECTRICAL. The stator plate assembly is insulated from the rigid end-plates, carrying the rotar assembly, by specially selected and treated porcelain blocks. As these blocks are small in volume, and placed in a weak, non-varying electrostatic field, the condenser has a very low power factor, .007% at 1000 MMF.

When using this condenser in measuring the power factor of absorbing condensers the fact that the field, where the porcelain supports are located, does not vary with condenser setting, is of importance, because it permits the assumption that the precision condenser is the equivalent of two condensers in parallel, one being a perfect condenser of variable capacity, the other a small fixed condenser with which is associated all the dielectric losses.

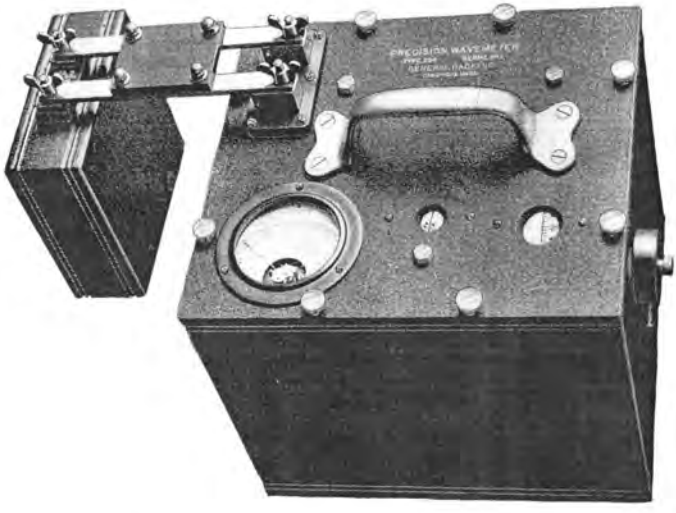
The temperature coefficient of this condenser is practically nil, and there is no change in capacity with frequency. The equivalent series resistance at 1000 cycles and 1000 MMF. is approximately 11 ohms. The breakdown potential is about 1000 volts.

SCALES AND CALIBRATION. Attached to the main shaft is a scale, divided into 25 equal parts, while on the worm shaft is a second scale, the circumference of which is divided into 100 equal parts. Since one complete turn of the worm shaft moves the main scale through one division, the position of the rotary plates may be read directly to 1 part in 2500,— equivalent to about 0.6 MMF. Since these sub-scale divisions are $\frac{1}{16}$ of an inch apart, it is easy to estimate to one-fifth of a division. Each condenser is supplied with a chart giving, with an accuracy of 0.1%, the condenser calibration at 26 points.

MOUNTING. The condenser is mounted on a $\frac{1}{4}$ inch aluminum plate, finished in permanent crystalline black. This plate forms the top of the case, which is of polished walnut and lined with a copper shield. In order that the condenser may be kept free from dust the two scales are read through glass windows set into the aluminum top. A hard rubber rotating handle extends into the box and engages the worm shaft. The carrying handle and other metal parts are finished in polished nickel.

A substantial whitewood carrying case, provided with lock and carrying handle, is furnished with each instrument.

Type 222L Precision Condenser $90.00
Dimensions $8\frac{1}{4}$" x $8\frac{3}{4}$" x 9". Weight 16 lbs.
Code Word " COPAL "



Type 224
PRECISION WAVEMETER
Range 75-24,000 meters (4,000-12.5 kilocycles)

This wavemeter is designed to provide an accurate instrument for laboratory service, yet sufficiently portable for general measurement work where precision is essential.

MECHANICAL. Since the condenser is the Type 222 described above, it is not necessary to repeat its description here. The coil mounting is rugged, and particular care has been taken to lock or pin all parts to keep them secure. The coils are wound and mounted in such a manner that the turns cannot become loose.

ELECTRICAL. A standard wavemeter must have low decrement giving sharp tuning. This has been accomplished in the Type 224 wavemeter by the use of a low loss condenser and by winding the inductances with stranded cable. In the design of these inductances, of which there are five, attention also has been given to the necessity for low dielectric losses, low distributed capacity, good form factor, and a reasonable amount of overlap in wave length.

To insure accuracy under all conditions no extra circuits such as a buzzer or detector are incorporated in the wavemeter. There is but one circuit, the calibrated oscillating circuit, which consists of the condenser, an inductance and a Weston thermo galvanometer for indicating resonance. This circuit is so connected that the condenser rotor plates, the condenser shield, the thermo galvanometer and the outside of the inductance coil are at low potential. This prevents disturbances due to variation in stray capacities.

SCALES AND CALIBRATION. The scale arrangement is the same as is used on the Precision Condenser. Mounted calibration curves are furnished for each coil. The standards used in calibrating are checked by the U. S. Bureau of Standards, and also checked in our own laboratory by stepping up frequencies of standard tuning forks by the harmonic method. A capacity calibration chart for 26 points on the condenser is also furnished. When making measurements of continuous waves, it is possible to determine the resonance point to ½ division of the sub-scale, thus giving an accuracy of 1 part in 10,000. The absolute values of frequency are accurate to .25 per cent.

MOUNTING. The condenser is mounted in a polished walnut case similar to that of the Precision Condenser. Each inductance coil is enclosed in a walnut box with an engraved hard rubber panel stating the wavelength range. The terminal blocks are so shaped that they will fit on to the connecting bars in one way only, thus insuring that each coil will always be connected in the same manner in which it was calibrated.

A strongly built whitewood shipping case is furnished with each wavemeter. Separate compartments are provided for the condenser and coils. This case is fitted with a carrying handle and lock.

Type 224 Precision Wavemeter $220.00

Dimensions 18″ x 11″ x 11″. Weight 34 lbs.

Code Word " WAGER "

(This Bulletin replaces Bulletin 709)

Standardize on General Radio Apparatus Throughout.

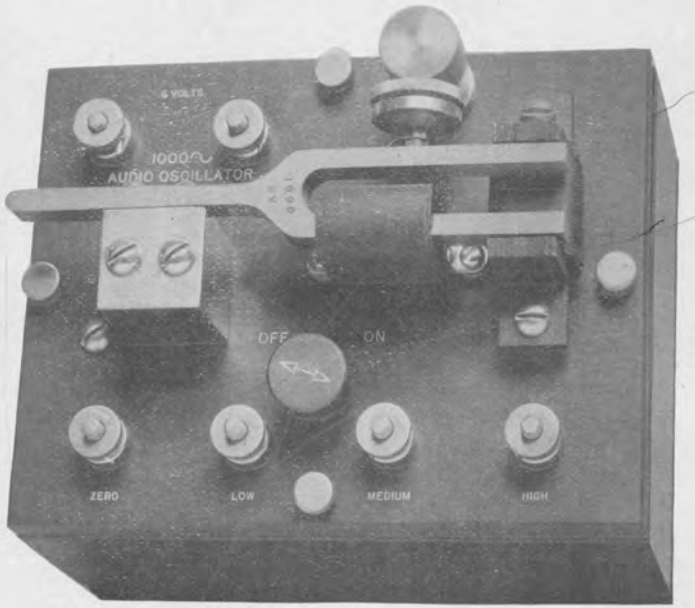
GENERAL RADIO COMPANY

MANUFACTURERS OF

ELECTRICAL AND RADIO LABORATORY APPARATUS

CAMBRIDGE, MASSACHUSETTS

BULLETIN 712 **NOVEMBER 1923**



AUDIO OSCILLATOR

Type 213

The precision of most alternating current bridge measurements is in no small measure dependent on the source of power supplied to the bridge. The waveform should be practically free from harmonics. Where a balance is indicated by means of the null method with a telephone receiver, the presence of harmonics of even very small magnitude will prevent the accurate determination of the balance point for the fundamental. The frequency must remain constant. The supply source should also be simple in its operation, rugged and reliable. It was to meet these requirements that the General Radio Co. Type 213 Audio Oscillator was designed.

The output of this oscillator is about 0.06 watt at 1000 cycles. External binding posts are so arranged that three output voltages may be obtained. The outputs obtainable with these three different connections are as follows:

Point	*Voltage*	*Current*
Low	0.5 volts	100 milliamperes
Medium	1.5 volts	40 milliamperes
High	5.0 volts	12 milliamperes

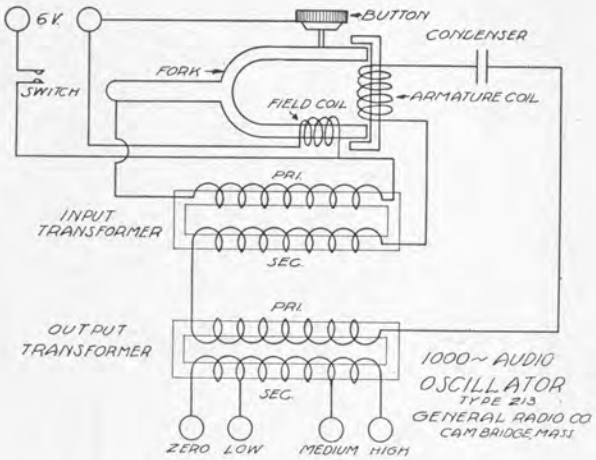
For some capacitance measurements it is desirable to use a high voltage. This increased voltage may be obtained by connecting an inductance and capacitance in series across the high voltage output terminals of the oscillator. By adjusting this circuit to resonance, voltages as high as 50 or 100 may be obtained by connecting output leads across the condenser. This instrument will operate satisfactorily on from four to eight volts. The input current is approximately 0.13 ampere. When running, the oscillator may be heard for a distance of approximately twenty-five feet, or may be made silent by enclosing in a sound-proof box.

The circuits of this oscillator are shown in the diagram. The closing of the switch places the field magnetizing coil directly across the battery. Also across the battery is the primary of the input transformer in series with the microphone button. The resonance circuit consists of the secondary of the input transformer, the primary of the output transformer, the armature coil and the condenser. The output transformer secondary has three taps to permit the obtaining of three different output voltages. The use of the two transformers prevents the output wave from containing any direct current component. Each transformer core has a small air gap to prevent distortion of the wave form. Since, however, the magnetic circuits are all nearly closed iron paths there is very little outside field. This feature is particularly important where the oscillator is being used in close proximity to the bridge. The tuning fork insures that the frequency be kept constant and at 1000 cycles. The resonance circuit is carefully adjusted to this value. Since the oscillator is self-starting it may be located at a point distant from the bridge and operated by a switch placed at the bridge.

By the use of the field magnetizing coil on one tine of the vibrating fork, instead of relying on its permanent magnetism, the polarity and intensity of the magnetization of the fork with respect to the armature are permanently maintained.

Success or failure in the operation of a hummer, or audio oscillator, lies very largely in the microphone button. If the button heats so that the oscillator cannot be run indefinitely, if the adjustment of the button is not permanent, or if slight mechanical shocks change its operating characteristics the oscillator has little commercial value. A distortion of as small an amount as one five-hundredth of an inch from normal mica will destroy the perfect operation of the button. In

order that the button may be insensitive to mechanical shocks and yet operate properly at 1000 cycles, use is made of its high inertia effect at the latter frequency. One side of the button is attached to the tuning fork by means of a short, flat spring. The other side, which has a



projecting mounting post, is held in position by a specially designed self-centering spring. This combination of springs enables the button to withstand severe shocks, yet it has sufficient inertia so that perfect operation is obtained. The adjustment of the button is permanent and needs no further attention after leaving our laboratory. This type of mounting, together with the fact that the electrical constants of the circuits have been adjusted to their optimum values, insures the continuous operation of the oscillator without heating.

It should, of course, be understood that this oscillator is not intended to displace the larger types of oscillators used where several watts of output are required. It is intended rather for general laboratory use where power of good waveform is desired for a single bridge. As the pureness of waveform is dependent on the load on the oscillator, whenever a pure waveform is essential the oscillator should not be overloaded. This oscillator is adapted for the usual alternating current measurements of inductance and capacitance.

The oscillator is mounted in a polished oak box and has an engraved bakelite panel. The exposed metal parts are finished in polished nickel. The control switch is easily accessible and is of the convenient lock button design.

Type 213 Audio Oscillator $32.00

Dimensions 6″ x 4¾″ x 5″. Weight 4½ lbs.

Code Word " AUGER "

Type 166
TELEPHONE TRANSFORMER

For many purposes in a laboratory a small iron core transformer of high and adjustable impedance is extremely useful. It may be used to advantage in impedance bridges employing a telephone receiver to detect the balance point. With this transformer it is possible to adjust the impedance of the telephone circuit to the most satisfactory value for the bridge circuit, independent of the telephone receiver impedance.

The winding is all on one leg of the core, but is in two separate parts so as to be used as a primary and secondary. These windings, however, may be connected in series should it be desired to use an auto transformer connection. Taps are brought out on both the primary and secondary windings so that it is possible to vary the impedance and the ratio of transformation. A small air gap is left in the iron core to prevent any possible distortion of wave form due to saturation of the iron. The panel is of bakelite with engraved lettering. Nickel plated binding posts are used as terminals for the taps. The following table shows the number of turns between each set of binding posts.

PRIMARY		SECONDARY	
1-2	150 Turns	5-6	1200 Turns
2-3	300 Turns	6-7	2400 Turns
3-4	600 Turns	7-8	4800 Turns

Type 166 Telephone Transformer $9.00
Dimensions 2¾″ x 2½″ x 2¼″. Weight 2 lbs.

Code Word " TOPIC "

(This Bulletin replaces Bulletin 706)

Standardize on General Radio Apparatus Throughout.

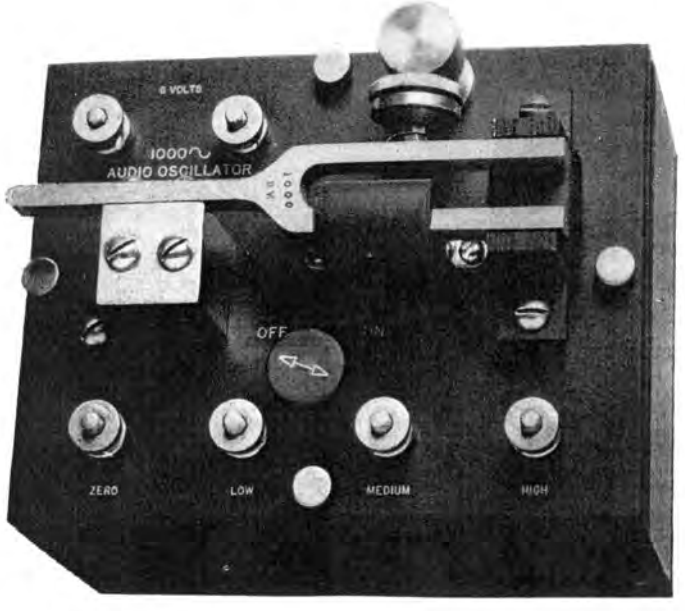
GENERAL RADIO COMPANY

MANUFACTURERS OF

ELECTRICAL AND RADIO LABORATORY APPARATUS

CAMBRIDGE, MASSACHUSETTS

BULLETIN 713 JANUARY 1925



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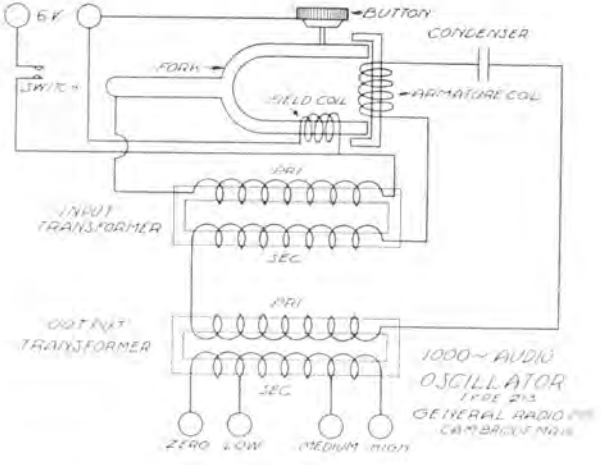


projecting mounting post, is held in position by a specially designed self-centering spring. This combination of springs enables the button to withstand severe shocks, yet it has sufficient inertia so that perfect operation is obtained. The adjustment of the button is permanent and needs no further attention after leaving our laboratory. This type of mounting, together with the fact that the electrical constants of the circuits have been adjusted to their optimum values, insures the continuous operation of the oscillator without heating.

It should, of course, be understood that this oscillator is not intended to displace the larger types of oscillators used where several watts of output are required. It is intended rather for general laboratory use where power of good waveform is desired for a single bridge. As the pureness of waveform is dependent on the load on the oscillator, whenever a pure waveform is essential the oscillator should not be overloaded. This oscillator is adapted for the usual alternating current measurements of inductance and capacitance.

The oscillator is mounted in a polished walnut box and has an engraved bakelite panel. The exposed metal parts are finished in polished nickel. The control switch is easily accessible and is of the convenient lock button design.

Type 213 Audio Oscillator..... $32.00

Dimensions 6″ x 4¾″ x 5″. Weight 4½ lbs.

Code Word "AUGER"

Type 166
TELEPHONE TRANSFORMER

For many purposes in a laboratory a small iron core transformer of high and adjustable impedance is extremely useful. It may be used to advantage in impedance bridges employing a telephone receiver to detect the balance point. With this transformer it is possible to adjust the impedance of the telephone circuit to the most satisfactory value for the bridge circuit, independent of the telephone receiver impedance.

The winding is all on one leg of the core, but is in two separate parts so as to be used as a primary and secondary. These windings, however, may be connected in series should it be desired to use an auto transformer connection. Taps are brought out on both the primary and secondary windings so that it is possible to vary the impedance and the ratio of transformation. A small air gap is left in the iron core to prevent any possible distortion of wave form due to saturation of the iron. The panel is of bakelite with engraved lettering. Nickel plated binding posts are used as terminals for the taps. The following table shows the number of turns between each set of binding posts.

PRIMARY		SECONDARY	
1-2	150 Turns	5-6	1200 Turns
2-3	300 Turns	6-7	2400 Turns
3-4	600 Turns	7-8	4800 Turns

Type 166 Telephone Transformer $9.00
Dimensions 2¾″ x 2½″ x 2¼″. Weight 2 lbs.
Code Word "TOPIC"

(This Bulletin replaces Bulletin 712)

Standardize on General Radio Apparatus Throughout.

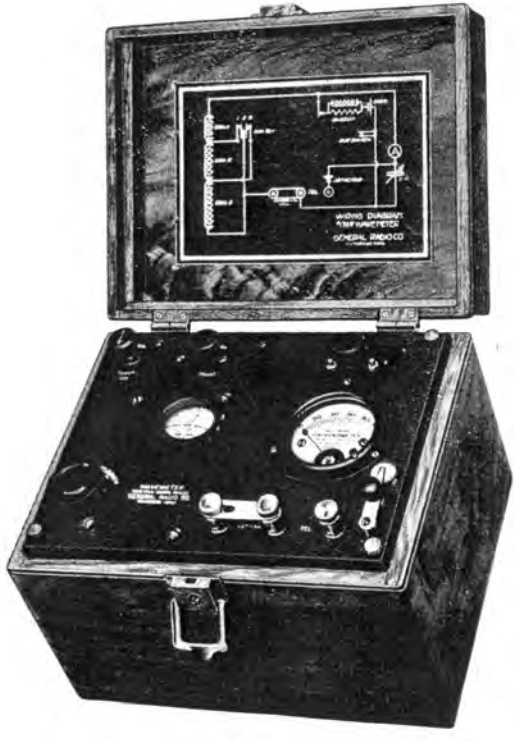
GENERAL RADIO COMPANY

MANUFACTURERS OF

ELECTRICAL AND RADIO LABORATORY APPARATUS

CAMBRIDGE, MASSACHUSETTS

BULLETIN 713 NOVEMBER 1923



TYPE 174

DIRECT READING WAVEMETER

The Type 174 Wavemeter is designed for general use in commercial and experimental radio stations. Its equipment is such that it is adapted for use with receiving or transmitting sets, employing either damped or undamped waves. Its self-contained, direct-reading features make this instrument particularly valuable for commercial work.

A hot wire galvanometer is used for indicating resonance of transmitted signals of average intensity, while for weak signals a crystal detector and binding posts for telephones are provided. For producing damped oscillations of known wavelengths, the wavemeter is equipped with a high frequency buzzer operating on a battery mounted within the wavemeter case. The oscillating circuit consists of three coils with a selector switch and a variable air condenser. This combination gives a wavelength range of 130 to 3000 meters. The inductance coils are bank-wound in order to keep the distributed capacity a minimum. The condenser is our low loss Type 239, equipped with slow-motion gear.

Particular care has been given to the mechanical construction and to the appearance of this instrument. All of the equipment is mounted on a hard rubber panel and enclosed in a polished walnut carrying case fitted with lock and key. The metal parts are finished in polished nickel.

OPERATION

The dial on which are drawn the three wavelength scales corresponding to the three inductance coils is mounted directly above the variable condenser and is fastened to the rotor plate shaft. The scales are indicated by the numbers 1, 2 and 3 engraved on the panel. Above the galvanometer is a switch engraved RANGE, with points numbered 1, 2 and 3. These three points correspond respectively to the three wavelength scales. Thus, when the wavemeter is set say at 360 meters, Scale 1 is used and the range switch set on Point 1. In addition to the three wavelength scales, a scale divided into one hundred equal divisions is provided. This scale is simply placed for reference and is convenient in making certain measurements.

TRANSMITTING SETS

In determining the wavelength of a transmitting set, the range switch should be set on the point covering the wavelength scale within which the transmitted wavelength should fall. The wavemeter should then be brought near the tuning inductance or the antenna or ground lead of the transmitter. By turning the knurled knob marked INCREASE WAVELENGTH, the variable condenser will be rotated, varying the wavelength of the wavemeter. At resonance — that is, the point where the wavelength of the wavemeter is the same as that of the transmitter — the maximum amount of energy will be transferred from the transmitting set to the wavemeter. This point is indicated by a maximum deflection of the hot wire galvanometer. Care, however, should be taken that the wavemeter is not too near a powerful transmitter because an excess amount of energy may be transferred to the wavemeter, causing the galvanometer to burn out. It will be found that with a sharply tuned transmitter, particularly when using

vacuum tubes, that the resonance point is very sharp. The condenser must be rotated slowly, as the galvanometer needle will swing from zero to nearly full scale and back again over a very small range of wavelengths. If the condenser is rotated too rapidly, the resonance point will be passed through without being noted. In the case of a buzzer or transmitter of small output, sufficient energy may not be radiated to operate the galvanometer. In this case, a pair of telephones should be connected to the binding posts marked TEL. Resonance will then be indicated by maximum intensity of signal in the telephones.

RECEIVING SETS

Two methods of determining the wavelength of a receiving set may be employed. The first, the reaction method, is applicable only to a vacuum tube receiving set, and then only when the set is oscillating. The wavemeter should be brought near the tuning inductance of the receiving set. By tuning the condenser of the wavemeter a sharp click will be heard in the head phones of the receiving set at the point where the condenser passes through the resonance point. The wavelength would then be read on the proper scale. It is usually necessary to have the wavemeter quite close to the receiving set. As the axis of the coils in the wavemeter is parallel to the panel, and extends from front to rear of the case directly beneath the galvanometer, best results are usually obtained by placing the right-hand edge of the wavemeter parallel to the tuning coil of the receiving set.

Where it is desired to set an inductively-coupled receiving set at a definite wavelength, the wavemeter should be set at that wavelength and the antenna circuit of the receiving set opened. The secondary of the receiving set should be adjusted either by means of the inductance or condenser until the reaction click is heard in the head phones of the receiving set. The wavemeter is then removed and the antenna circuit reconnected. The antenna circuit should then be varied until a click is again heard in the head phones. This will indicate that the primary and secondary circuits of the receiving set are both adjusted to the same value and to the value set on the wavemeter. This method requires, of course, that the set be oscillating during adjustment.

Where a single circuit receiving set is used, the antenna and ground connections should be left on. The tuning condenser is varied until the reaction click is heard in the telephone receivers. As with the inductively-coupled receiving set, the vacuum tube must be oscillating while the wavelength adjustments are being made.

A much quicker but slightly less accurate way to adjust the receiver is by means of the buzzer on the wavemeter. The wavemeter is set at the desired wavelength and the buzzer turned on by means of the buzzer switch. The receiving set should then be adjusted until the maximum intensity of buzzer signal is heard in the head phones. This method of adjustment is similar to tuning to an incoming signal.

GENERAL

Because of the sensitive type of buzzer used, it may be found that on turning the buzzer switch no sound can be heard. The buzzer adjusting screw should be turned to the right or left until the buzzer starts to operate. If the buzzer will not operate, make certain that the battery is in good condition. When a wavemeter is shipped, no battery is placed in the wavemeter, but one is shipped separately. This method is used to prevent damage to the wavemeter in case it should remain unused for a long time. Dry cells kept for a long time in an inverted or horizontal position will deteriorate and leak; the wavemeter should, accordingly, always be stored so that the cover is on top, thus keeping the battery in an upright position.

The diagram mounted in the cover should be studied carefully in order to understand the wavemeter circuits. The four panel thumbscrews should be removed and the panel lifted from the case. The inside of the wavemeter should be examined to become familiar with its mechanical operation, but under no circumstances should adjustments be attempted, as they will affect the calibration. The buzzer battery should be put in place before replacing the panel. It will be noted that provision has been made on the panel for an external coil. This arrangement is to enable an additional coil to be used for special work. Under normal conditions the short circuit bar between the two binding posts marked EXT COIL should not be removed. This is true even when the telephone receivers are connected to the telephone binding posts. This bar is removed only when an external coil is used.

Type 174 Direct Reading Wavemeter $68.00

Dimensions 9″ x 7″ x 6″. Weight 6¾ lbs.

Code Word: "WITTY."

The products of the General Radio Company cover a complete line of radio and electrical laboratory apparatus. Information and bulletins of special apparatus will be sent on request. Our line includes the following: Variable Air Condensers, Vernier Condenser, Standard Condensers, Decade Condensers, Variometers, Standards of Inductance, Standards of Resistance, Decade Resistance Boxes, Wavemeters, Decade Bridge, Capacity Bridge, Slide Wire Bridge, Audibility Meters, Hot Wire Meters, Galvanometers, Thermo-Couples, Telephone Transformers, Miscellaneous Apparatus.

All prices in this bulletin are strictly net, subject to change without notice, F. O. B. Cambridge, Mass. Cash should accompany orders from persons or firms with whom we have not already opened accounts. Unless otherwise instructed we shall use our own judgment regarding method of shipment.

(This Bulletin replaces Bulletin 708)

Standardize on General Radio Apparatus Throughout

GENERAL RADIO COMPANY

MANUFACTURERS OF

ELECTRICAL AND RADIO LABORATORY APPARATUS

CAMBRIDGE, MASSACHUSETTS

BULLETIN 714 **JANUARY 1925**

TYPE 174

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Particular care has been given to the mechanical construction and to the appearance of this instrument. All of the equipment is mounted on a hard rubber panel and enclosed in a polished walnut carrying case fitted with lock and key. The metal parts are finished in polished nickel.

OPERATION

The dial on which are drawn the three wavelength scales corresponding to the three inductance coils is mounted directly above the variable condenser and is fastened to the rotor plate shaft. The scales are indicated by the numbers 1, 2 and 3 engraved on the panel. Above the galvanometer is a switch engraved RANGE, with points numbered 1, 2 and 3. These three points correspond respectively to the three wavelength scales. Thus, when the wavemeter is set say at 360 meters, Scale 1 is used and the range switch set on Point 1. In addition to the three wavelength scales, a scale divided into one hundred equal divisions is provided. This scale is simply placed for reference and is convenient in making certain measurements.

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Type 174 Direct Reading Wavemeter..... $68.00
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(This Bulletin replaces Bulletin 713)

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GENERAL RADIO COMPANY

MANUFACTURERS OF

ELECTRICAL AND RADIO LABORATORY APPARATUS

CAMBRIDGE, MASSACHUSETTS

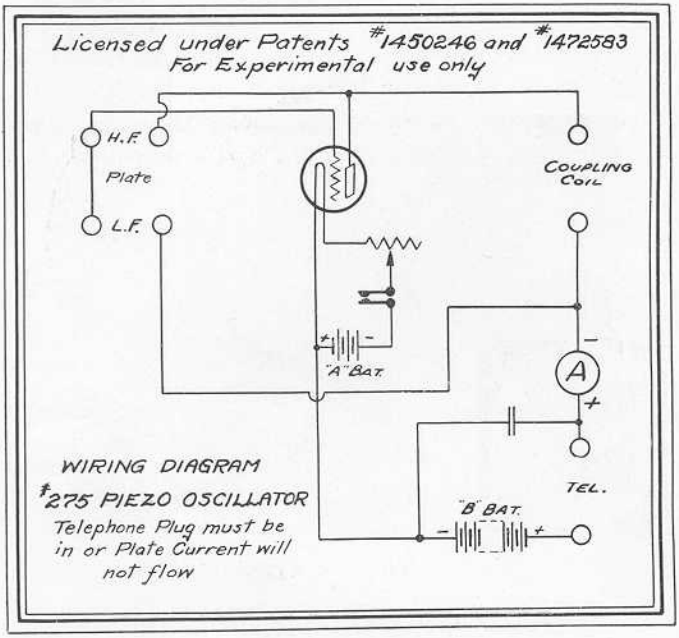
BULLETIN 715 **NOVEMBER 1925**

Type 275
PIEZO ELECTRIC OSCILLATOR
Type 276—QUARTZ PLATE

The piezo electric properties of crystaline quartz make it particularly well adapted for use as a frequency standard. Plates of this material when properly prepared, and placed in the circuit shown on page 758 will hold the frequency to extremely minute variations. The oscillating frequency is independent of the electrical constants of the circuit. The frequency is entirely dependent on the physical dimensions of the quartz plate which may be ground very closely to specifications. The frequency is practically unvarying with temperature and is not affected by any mechanical shock which does not fracture the plate.

The General Radio Company working in conjunction with Dr. W. G. Cady and Dr. G. W. Pierce has developed a commercial application of this principle.

The instrument is entirely self-contained and consists of the components shown in the wiring diagram shown below, mounted in a suitable cabinet which includes all necessary batteries. As the plate mounts on the front of the panel with a plug-in arrangement, plates may be readily exchanged in order to extend the frequency range. A coil is provided for coupling with other apparatus.

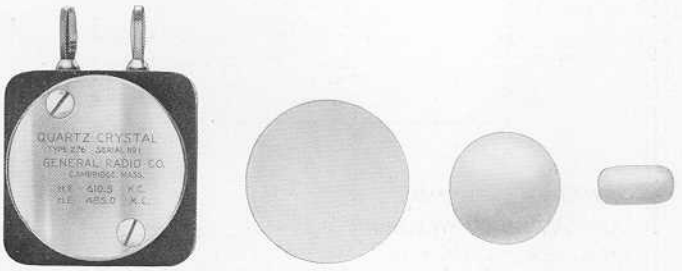


The oscillator circuit is shown above. A UV 199 tube is used as an oscillator. The meter, mounted on the front of the panel, indicates when the circuit is oscillating. A pair of telephones or similar high impedance must be connected at the plugs marked "TEL". The Quartz Plate is plugged in, either at H F or L F, depending on the frequency at which it is to oscillate. In general, plates for frequencies higher than 500 K. C. should be used in the H F mounting. Reasonable care should be taken in handling the plates, as they will fracture if subjected to too great a mechanical shock.

Limits are imposed on the fundamental frequencies for which it is possible to provide plates by physical conditions. The lower frequencies require a very large plate, while for the higher frequencies the plates

become very thin, difficult to handle, and fragile. The practical limits at present are about 100 and 1500 kilocycles. Lower and higher frequencies are readily obtained from these fundamentals, as the oscillator output is rich in harmonics.

Where it is desired to use the weaker harmonics of the plate, an oscillating vacuum tube is coupled to the oscillator output. The auxiliary oscillator may then be tuned to the harmonics of the quartz controlled tube by the beat method. Harmonics as high as the thirtieth may be made use of by this method. Lower frequencies than the fundamental may also be obtained by means of the auxiliary tube. The auxiliary tube is adjusted to the lower frequency by tuning it for dead beat between its harmonic of the desired order, and the quartz-controlled oscillator. By means of this device, a single plate may be used to obtain a great number of frequencies.



QUARTZ PLATES

Three classes of plates are provided. Where a wavemeter standard is desired, and the exact points of calibration are immaterial, a plate can be provided without grinding. Plates of this class are provided with the usual mounting, and the fundamental frequency measured to 0.1%, engraved on the cover. They can usually be supplied within 25% of any specified frequency within the above range. By making use of harmonics, one plate may be used for a number of calibration points. Where a closer approximation to a specified frequency is desired, plates may be provided within 5% of the required frequency. Where the requirements are still more rigid, plates may be ground to within 0.1% of the specified frequency.

The entire instrument is enclosed in a walnut cabinet, containing all batteries. The price includes batteries and tubes, coupling coil and one plate.

USES

In the General Radio Type 275 Oscillator the principle of frequency control by the use of quartz crystals has been made available for general experimental use. The 275 Oscillator is intended primarily as a frequency standard. As such it offers numerous advantages over the ordinary standard wavemeter as a primary standard. The entire equipment is considerably less bulky than the wavemeter, and the essential standard of frequency, the quartz plate is of vest-pocket dimensions. The frequency is affected only by some change in the physical dimensions of the plate or in the holder clearances. The development of a small, reliable frequency standard, suggests the possibility of uniform frequency standards, provided by a central laboratory, ending the present interference between stations due to a difference in standards.

Licensed under Pats. No. 1450246 and 1472583 for experimental use only.

Weight complete 15 lbs.

Dimensions 12½″ x 9 ¾″ x 8 ¼″.

PRICES—

Oscillator complete with one plate	$110.00
Oscillator complete with one plate ground to specified frequency	135.00
Plates, mounted each	25.00
Plates, mounted ground within 5% of specified frequency	35.00
Plates, mounted ground to specified frequency	50.00

ALL THE ABOVE PRICES ARE NET.

GENERAL RADIO COMPANY

MANUFACTURERS OF

ELECTRICAL AND RADIO LABORATORY APPARATUS

CAMBRIDGE 39, MASSACHUSETTS

BULLETIN 716 **MARCH 1926**

TYPE 332

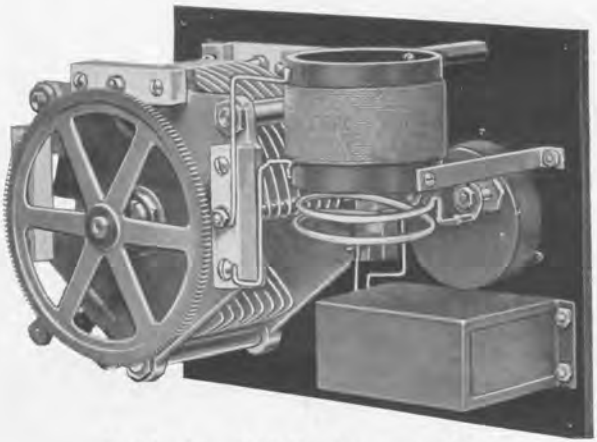
STATION FREQUENCY METER

Transmitting stations, such as broadcast stations, operating at a fixed frequency require a frequency meter of great precision at a fixed point.

The General Radio Type 332 Station Frequency Meter was developed for use by this class of station. It is not a fixed frequency indicator, but a frequency meter covering a limited band on each side of the station frequency. This type of meter offers considerable advantage over those having a single point indication in that it is possible to tell at any time how far off its frequency the station is operating, and whether it is above

or below its proper frequency. This greatly facilitates adjustment of the transmitter.

The instrument is of the usual wavemeter design, except that the range is small, extending about 5% of the station frequency on each side of the calibration point. A variable condenser of small maximum is shunted by a fixed condenser to get the required capacity. This device permits the use of an air condenser with very wide spacing without making the instrument bulky. Increasing the condenser spacing lessens the change in capacity under temperature variations.



Inside view of Station Frequency Meter

As a range of but 10% of the operating frequency is spread over the entire scale of the Type 332 Meter, the scale may be read directly to .1%. The station frequency is at the middle of the scale and is accurately set at our laboratory. The Bureau of Standards will also supply calibration on these meters if desired. The meter must be sent to the Bureau by the purchaser for this check.

When the meter is coupled to the oscillating circuit the resonance point is indicated by means of a thermo-ammeter.

The instrument is completely enclosed in a walnut case with leather carrying-handle. The hinged top is removable, so that the meter may be permanently installed.

USES

The Type 332 Station Frequency Meter is adapted for use as a control frequency meter for transmitting stations operating on a fixed frequency.

Its construction permits its installation on the operating desk, where the operator may have under his observation an indication of the transmitter frequency. When permanently installed the meter deflection will also give an indication of the power being developed in the oscillator.

The meter may be supplied with either wavelength or frequency calibration, but will be calibrated in frequency unless otherwise specified.

Type 332 Station Frequency Meter.....$170.00

Dimensions, 8½" x 10¾" x 8¼". Weight, 13 lbs.

Code Word: "SENNA."

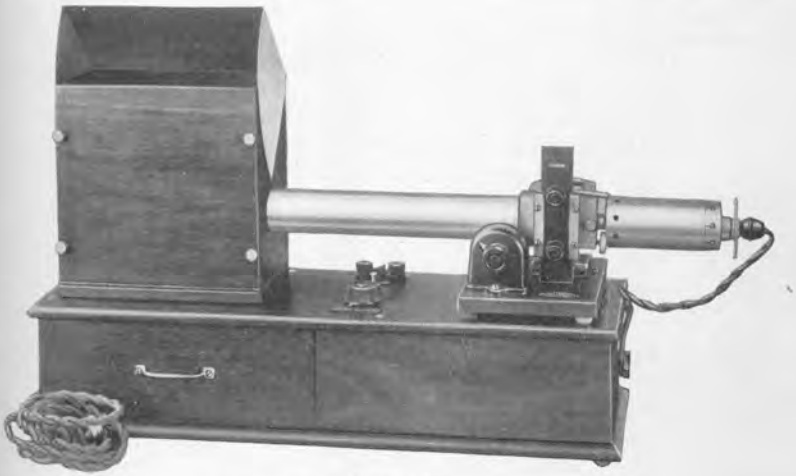
GENERAL RADIO COMPANY

MANUFACTURERS OF

ELECTRICAL AND RADIO LABORATORY APPARATUS

CAMBRIDGE 39, MASSACHUSETTS

BULLETIN 717 **MARCH 1926**



TYPE 338

STRING OSCILLOGRAPH

In 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 wave forms or transient currents and voltages existing at any point in an electrical circuit or network. To meet this requirement the General Radio Company has designed a compact and moderately priced outfit which may be used for two distinct purposes:

1. As a string oscillograph which operates with much less power than is usually required by such instruments, but which affords a satisfactory means for the visual examination of wave forms over a wide range of frequencies. The wave of either current or voltage is traced by the shadow image of a very fine vibrating wire rather than by a spot of light reflected from a mirror attached to a moving system. The vibrating element can, accordingly, be made much lighter, resulting in an increased sensitivity of the instrument. The uses for such an instrument are manifold, as, for example: the observation of large or small alternating currents in the laboratory, power house, or class room; the visual examination of telephonic currents in simple or complicated circuits; the study of mechanical vibrations (when combined with some form of microphone or magnetophone) occurring in moving machinery, or in bridges or other

structures subject to intermittent stresses; etc. For many such lines of work the portable nature of the equipment is of especial value. If the oscillograph is connected in series with the loud speaker of a radio receiving set, an instructive and entertaining result will be obtained.

2. As a reliable vibration galvanometer, the string of which may be tuned to give a good degree of sensitivity at any desired frequency over a considerable range. In this respect the instrument is especially useful as a null point detector in A. C. bridge measurements when using low frequencies at which the telephone receiver becomes insensitive and otherwise unsatisfactory. As the galvanometer has no coil in the magnetic field, its reactance is practically nil when the string is not vibrating, a feature which is desirable for certain applications.

An idea of the sensitivity of the instrument may be obtained from the following data: Using a string of 0.0004 inch tungsten wire, undamped, and tuned to the fundamental of the applied A. C. frequency, the following potentials are required to produce a wave form having an amplitude of one millimeter:

At	60 cycles	0.2 millivolts
At	250 "	1.0 "
At	500 "	2.4 "
At	1000 "	8.5 "

The D. C. sensitivity of the same string when tuned at various frequencies is seen from the following data, which give the D. C. potentials required to give a deflection of one millimeter on the screen:

At	60 cycles	0.0047 volts
At	250 "	0.065 "
At	500 "	0.30 "
At	1000 "	1.31 "

The resistance of the instrument strung with the 0.0004 inch tungsten wire is of the order of 65 ohms.

The complete equipment of the string oscillograph comprises the following items:

1. A galvanometer, Type 338–20.
2. A rotating mirror box, Type 338–21.
3. An oscillograph base cabinet, Type 338–22.
4. A carrying-case, Type 338–12, for readily storing or transporting the instrument.
5. A convenient piece of auxiliary apparatus consists of an adjustable rheostat, Type 340, having a total resistance of 100,000 ohms. This, placed in series with the oscillograph, enables the same to be used with voltages up to 500.
6. Another useful piece of auxiliary equipment consists of a step-down transformer, Type 285-N, to adapt the oscillograph for efficient operation in high impedance circuits.

A motor-driven film camera is being developed to be used with this equipment.

The appearance of the outfit may be seen from photograph. A walnut base cabinet serves to support and properly align the parts. In

the left portion of this is a drawer for holding spare string mountings and other equipment.

The galvanometer is mounted upon the right-hand end of the cabinet. It is sensitized by two permanent magnets, thus eliminating the need of a source of direct current for producing the necessary magnetic field. Two specially shaped pole pieces afford a long, narrow, vertical gap in which the string vibrates, and at the same time serve to support the optical system, which consists of a large and a small condenser lens, together with a microscope objective. The large lens and the standard automobile headlight bulb used are located in the lamp chamber seen on the extreme right, while the two small lenses are located within a tube passing through the pole pieces. All three lenses are adjustable along the optical axis, while the lamp is adjustable in three dimensions. This makes it easy to focus the system to give a uniform field of illumination. A thumb-screw, located on the left end of the lamp chamber, slides the optical system as a whole with reference to the string and thereby focuses the shadow image of the same upon the observing screen.

The string is mounted upon a metal rocker arm, which, in turn, is attached to the rear of a vertical bakelite strip, shown in the photograph. Two adjustment screws will be seen protruding through the front of this strip. One of these varies the tension on the string while the other serves to move the string across the light beam in order to center the image on the screen. Provision is made for damping the vibration of the string, if desired, by means of two drops of oil. The whole string assembly is readily removable, electrical contact being made through two springs on the galvanometer base. Two string mountings are provided with the equipment, one strung with a very fine tungsten wire about .0004 inch in diameter, while the other is strung with a coarser wire. These strings, which are each 4½ inches in length, may be considerably overloaded without damage. As they carry no mirror their replacement, if accidentally broken, is a comparatively simple operation.

On the left of the galvanometer base is mounted an enclosed potentiometer for adjusting the potential applied to the string, and hence controlling the amplitude of vibration.

On the left of the cabinet is mounted the mirror box, which is likewise made of walnut. This contains a rotating octagonal metallic mirror which affords the necessary time element of linear motion perpendicular to the vibration. The mirror is mounted on the shaft of a small induction motor and is provided with jewelled bearings. This motor is of simple construction, consisting of a circular disc, the periphery of which passes through a gap in a rectangular, laminated core. The core is energized by a high impedance coil carrying a 60-cycle current and is surrounded by two copper rings acting as "shading coils" around one half of the cross section of each pole. The unsymmetrical distortion of the resulting field affords the driving torque. This motor is not inherently synchronous, as its speed may be controlled over a wide range merely by varying the voltage impressed on the energizing coil. This is done by means of a potentiometer, the knob of which is seen in the center of the cabinet. A very constant speed of any desired value may be maintained

in this manner, which makes it easy to synchronize the motor to any frequency impressed on the string, producing thereby a stationary wave pattern. For observing transient phenomena of some duration, it is desirable to have the mirror run quite slowly, while the maximum speed of the motor is necessary to separate the individual wave forms at the higher frequencies. The 60-cycle wavelength at maximum speed is from 2½ to 3 inches, giving a wavelength of about 1/16 inch at 3000 cycles.

A screen bent on the arc of a circle is seen by looking down into the box, which is provided with an adjustable metallic cover that serves as a hood for shielding the screen when desired. The observer may stand at some distance from the screen and still watch the wave form while manipulating other apparatus. This is a convenient feature. A cylindrical lens is mounted in the mirror box for concentrating the light beam into a narrow line. This sharpens and intensifies the image considerably. The front vertical wall of the mirror box is easily removable for inspection and adjustment of the enclosed parts.

Terminal posts, together with a cord and plug, are provided for attaching the equipment to a source of 60-cycle, 110-volt current which may conveniently be turned on or off by a small plunger switch mounted on the center portion of the cabinet. This is the only source of power required, as the lamp is lit through a step-down transformer mounted in the cabinet. The whole outfit takes about 40 watts.

The cabinet contains a 3 MF. paper condenser which is frequently useful for eliminating a D. C. component from the string.

An aluminum tube connecting the galvanometer with the mirror box is sometimes a help in reducing extraneous illumination of the screen.

When the outfit is desired for use only as a vibration galvanometer it may be procured without the mirror box, but provided with a longer tube having a small translucent screen for observing the image of the vibrating string. In front of this is a small cylindrical lens for concentrating the light beam and intensifying the image. A metallic support is provided for the outer end of this tube.

Galvanometer, Type 338–20 ..... $80.00
Mirror Box, Type 338–21 ..... 60.00
Cabinet, Type 338–22 ..... 40.00
Carrying-Case 20.00

Type 338 Oscillograph, with Carrying-Case $200.00
Dimensions, 30″ x 11″ x 17″. Weight, 61 lbs.
Code Word: "OFFER"

Type 338–20 Vibration Galvanometer Equipment, with Carrying-Case $140.00
Dimensions, 30″ x 11″ x 17″. Weight, 53 lbs.
Code Word: "OFTEN"

Rheostat, Type 340 ..... $14.00
Transformer, Type 285-N 10.00

GENERAL RADIO COMPANY

MANUFACTURERS OF

ELECTRICAL AND RADIO LABORATORY APPARATUS

CAMBRIDGE 39, MASSACHUSETTS

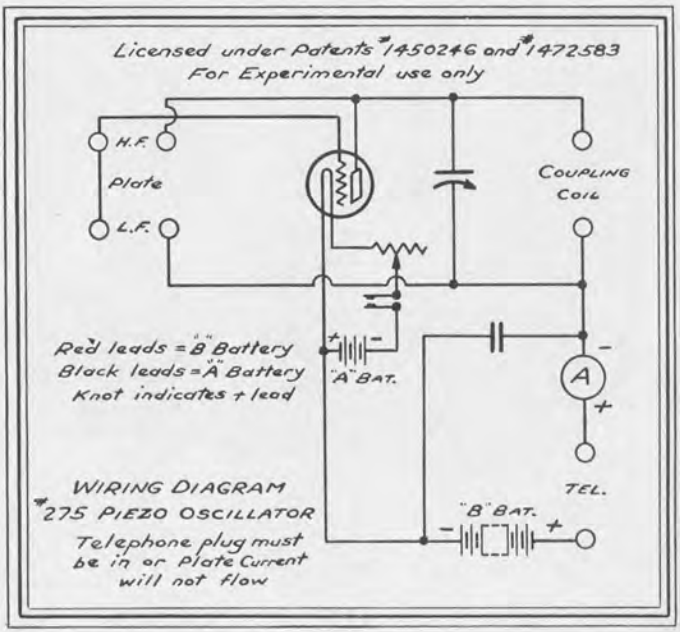
BULLETIN 718 **MARCH 1926**

TYPE 275
PIEZO ELECTRIC OSCILLATOR
TYPE 276—QUARTZ PLATE

The piezo electric properties of crystalline quartz make it particularly well adapted for use as a frequency standard. Plates of this material when properly prepared, and placed in the circuit shown on page 768, will hold the frequency to extremely minute variations. The oscillating frequency is independent of the electrical constants of the circuit. The frequency is entirely dependent on the physical dimensions of the quartz plate which may be ground very closely to specifications. The frequency is practically unvarying with temperature and is not affected by any mechanical shock which does not fracture the plate.

The General Radio Company, working in conjunction with Dr. W. G. Cady and Dr. G. W. Pierce, has developed a commercial application of this principle.

The instrument is entirely self-contained and consists of the components shown in the wiring diagram below, mounted in a suitable cabinet which includes all necessary batteries. As the plate mounts on the front of the panel with a plug-in arrangement, plates may be readily exchanged in order to extend the frequency range. The tuned circuit must be adjusted approximately to the frequency of the quartz plate, or the system will not oscillate. The system will oscillate only at the frequency determined by the plate, and not at the frequency of the tuned circuit. The coil is mounted externally and is suitable for coupling to other apparatus.



The oscillator circuit is shown above. A UX-199 tube is used as an oscillator. The meter, mounted on the front of the panel, indicates when the circuit is oscillating. A pair of telephones or similar high impedance must be connected at the plugs marked "TEL." The Quartz Plate is plugged in, either at H.F. or L.F., depending on the frequency at which it is to oscillate. In general, plates for frequencies higher than 500 K.C. should be used in the H.F. mounting. Reasonable care should be taken in handling the plates, as they will fracture if subjected to too great a mechanical shock.

Limits are imposed on the fundamental frequencies for which it is possible to provide plates by physical conditions. The lower frequencies require a very large plate, while for the higher frequencies the plates

become very thin, difficult to handle, and fragile. The practical limits at present are about 100 and 1500 kilocycles. Lower and higher frequencies are readily obtained from these fundamentals, as the oscillator output is rich in harmonics.

Where it is desired to use the weaker harmonics of the plate, an oscillating vacuum tube is coupled to the oscillator output. The auxiliary oscillator may then be tuned to the harmonics of the quartz-controlled tube by the beat method. Harmonics as high as the thirtieth may be made use of by this method. Lower frequencies than the fundamental may also be obtained by means of the auxiliary tube. The auxiliary tube is adjusted to the lower frequency by tuning it for dead beat between its harmonic of the desired order and the quartz-controlled oscillator. By means of this device, a single plate may be used to obtain a great number of frequencies.

QUARTZ PLATES

Three classes of plates are provided. Where a wavemeter standard is desired, and the exact points of calibration are immaterial, a plate can be provided without grinding. Plates of this class are provided with the usual mounting, and the fundamental frequency measured to 0.1%, engraved on the cover. They can usually be supplied within 25% of any specified frequency within the above range. By making use of harmonics, one plate may be used for a number of calibration points. Where a closer approximation to a specified frequency is desired, plates may be provided within 5% of the required frequency. Where the requirements are still more rigid, plates may be ground to within 0.1% of the specified frequency.

The entire instrument is enclosed in a walnut cabinet, containing all batteries. The price includes batteries and tubes, coupling coil, and one plate.

USES

In the General Radio Type 275 Oscillator the principle of frequency control by the use of quartz crystals has been made available for general experimental use. The 275 Oscillator is intended primarily as a frequency standard. As such it offers numerous advantages over the ordinary standard wavemeter as a primary standard. The entire equipment is considerably less bulky than the wavemeter, and the essential standard of frequency, the quartz plate, is of vest-pocket dimensions. The frequency is affected only by some change in the physical dimensions of the plate or in the holder clearances. The development of a small, reliable frequency standard suggests the possibility of uniform frequency standards, provided by a central laboratory, ending the present interference between stations due to a difference in standards.

Licensed under U. S. Pats. Nos. 1450246 and 1472583 for experimental use only.

Dimensions, 10″ x 11″ x 8″. Weight complete, 19 lbs.

Prices:

Oscillator complete with one plate	$115.00
Oscillator complete with one plate ground to specified frequency	145.00
Plates, mounted, each	30.00
Plates, mounted ground within 5% of specified frequency	40.00
Plates, mounted ground to specified frequency	60.00

This Bulletin replaces Bulletin No. 715.

GENERAL RADIO COMPANY

MANUFACTURERS OF

ELECTRICAL AND RADIO LABORATORY APPARATUS

CAMBRIDGE, MASSACHUSETTS

BULLETIN 803 **NOVEMBER 1926**

TYPE 377

LOW FREQUENCY OSCILLATOR

Many forms of electrical and physical research problems require a source of alternating current of good wave form and variable over a wide range of frequencies. The properties of the oscillating vacuum tube make it inherently adapted for use as such a source.

In consequence of a licensing agreement with the Radio Corporation of America, the General Radio Company is now able to supply such an oscillator for laboratory use.

The Type 377 Vacuum Tube Oscillator has a frequency range of from 60 to 75,000 cycles, extending through the audio and carrier frequency ranges into the lower radio frequencies. The simplified circuit of the oscillator is shown in Fig. 1. The frequency of the oscillating tube (left) is controlled by tuning the plate circuit. The output of the oscillating tube is fed through a coupling potentiometer to the amplifier tube (right). The plate of the amplifier tube connects direct to the output terminals. The parallel feed system of plate supply is used on both tubes.

The front panel assembly of the oscillator is shown on the first page of this bulletin. The meters are so equipped with switching arrangements that filament or plate voltage and oscillator or amplifier plate current may be read. The two switches directly under the meters are the transfer switches.

The output of the oscillator is adjustable and may be held constant over the frequency range by means of the potentiometer coupling to the amplifier tube. The resistance marked FEEDBACK is in the plate of the oscillator tube, and controls oscillation. For most satisfactory wave form the feedback control should be set at the point at which the tube just begins to oscillate.

The frequency is continuously variable by means of the seven controls on the lower part of the panel. There are three coils so tapped as to give six switch positions, and a decade capacity system extending from .001 MF. to 10 MF. An air condenser with maximum of 0.0011 MF. makes the capacity system continuously variable.

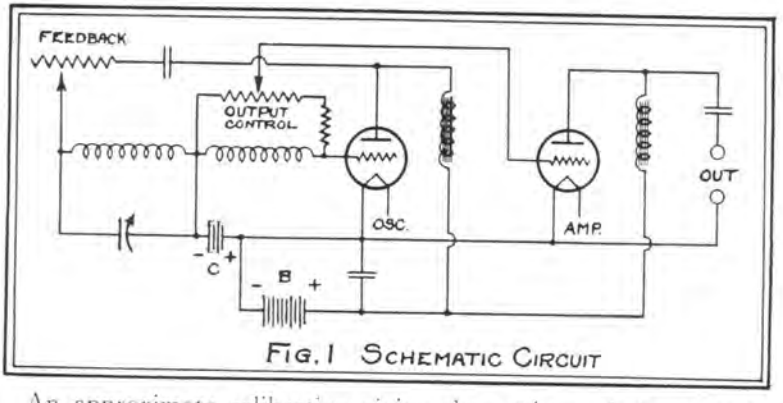


FIG. 1 SCHEMATIC CIRCUIT

An approximate calibration giving the settings of the controls at frequency intervals of about ten per cent for the entire frequency range is provided with each instrument.

The oscillator is intended to be used with either UV-201A, UX-112 or UX-210 tubes. For average use the UX-112 type will be found satisfactory.

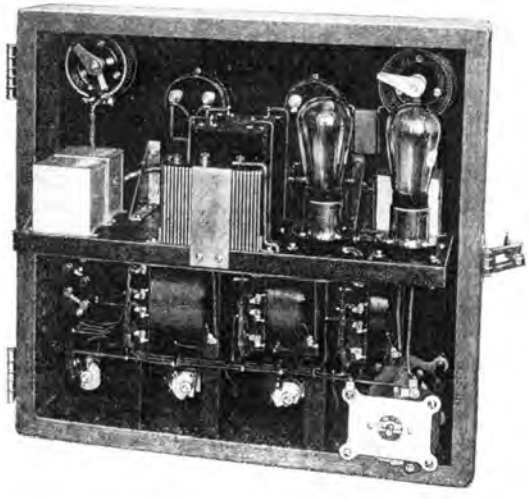
The wave form of the oscillator output is very closely sinusoidal. The largest single harmonic component in the voltage wave is of the order of two per cent. Where particularly good wave form is required, it is advisable to use tubes of the UX-210 type. Load does not affect wave form unless the amplifier tube is overloaded. The load will not affect the frequency, as it is not applied directly to the oscillating tube.

Frequency does not vary more than one per cent under ordinary variations in tube conditions.

The power output of the instrument will vary with the plate voltage and the type of tube. With a UX-210 tube, the output is about .2 watt with 120 volts on the plate and about .5 watt with 220 volts on the plate.

The entire oscillator is mounted in a sturdy oak cabinet with sub-

stantial brass carrying-handles and clasp. The panel swings outward, giving easy access to the instruments, all of which are mounted on the back of the panel.



INSIDE VIEW OF LOW FREQUENCY OSCILLATOR

Battery and output connections are carried through holes in the cabinet and made to the back of the panel. No external binding posts appear. The cabinet is strong enough so that the oscillator may be hung from a wall by means of bolts through the back of the cabinet if desired.

Space sufficient for five blocks of plate batteries of the 3¼" x 2¾" x 5⅝" size is provided in the cabinet, providing 112.5 volts.

USES

The low-frequency oscillator will be found of great use in all measurement work at audio, carrier and low radio frequencies. Among its uses are bridge measurements of all kinds, studies of the response curves of transformers and loudspeakers, and the study of filter characteristics, and studies of cable and other dielectric behavior.

Other vacuum tube oscillators are under development.

Oscillators for special ranges and single frequencies (for laboratory use only) will be provided to the customer's order.

Type 377 Low Frequency Oscillator $400.00

Licensed under Pat. No. 1113149, for radio laboratory experimental use only where no business features are involved.

Dimensions, 19⅛" x 18" x 10½". Weight, 50 lbs.

Code Word: "OMEGA."

The products of the General Radio Company cover a complete line of radio and electrical laboratory apparatus. Information and bulletins of special apparatus will be sent on request. Our line includes the following:

Standards of Inductance	Thermo-Couples	Variometers
Standards of Resistance	Hot Wire Meters	Capacity Bridge
Variable Air Condensers	Galvanometers	Decade Bridge
Decade Resistance Boxes	Oscillograph	Decade Condensers
Telephone Transformer	Audibility Meters	Vacuum Tube Oscillators
	Wavemeters	

All prices in this bulletin are strictly net, subject to change without notice, F. O. B. Cambridge, Mass. Cash should accompany orders from persons or firms with whom we have not already opened accounts. Unless otherwise instructed we shall use our own judgment regarding method of shipment.

GENERAL RADIO COMPANY

MANUFACTURERS OF

ELECTRICAL AND RADIO LABORATORY APPARATUS

CAMBRIDGE, MASSACHUSETTS

BULLETIN 804 **DECEMBER 1926**

MISCELLANEOUS TRANSFORMERS

There are many instances in radio and telephone work where circuits of different impedances are coupled together, requiring some form of impedance adjusting device.

The General Radio Company manufactures an extensive line of impedance adjusting units for various requirements. These include both fixed ratio transformers for specific needs and variable ratio transformers for laboratory use which may be adapted to a wide range of circuit impedances.

VARIABLE RATIO TRANSFORMERS

For general laboratory purposes a transformer of variable ratio is frequently convenient. Such a transformer may be connected in circuit and the ratio adjusted until the maximum energy transfer is obtained.

The Type 359 Transformers are provided in several models, each having a power rating of 25 watts. The ratio is varied on all types by means of the switch, as illustrated. The primary coil in each case is fixed, while the secondary may be adjusted to step down (ratios less than unity) or to step up (ratios greater than unity) the impedance.

Types 359A to 359D inclusive are adapted for working out of circuits having impedances of from 6000 to 20,000 ohms, at frequencies above 60 cycles. Types 359E to 359H inclusive are designed to give the same variable ratios with the primary working out of circuits having an impedance of the order of 600 ohms. Types 359C, D, G and H are auto transformers, while Types 359B, E and F have separate primary and secondary windings. They are provided with terminals to fit the Type 274 plug, a convenient feature which facilitates circuit changes.

Type 359A Transformer

Turns ratio (sec. to pri.) 0.025, 0.35, 0.5, 0.7, 1.0, 1.4.

Type 359B Transformer

Turns ratio (sec. to pri.) 0.06, 0.09, 0.13, 0.18, 0.25, 0.35.

Type 359C Auto Transformer

Turns ratio (sec. to pri.) 0.025, 0.35, 0.5, 0.7, 1.0, 1.4.

Type 359D Auto Transformer

Turns ratio (sec. to pri.) 0.06, 0.09, 0.13, 0.18, 0.25, 0.35.

Types 359A to D inclusive are designed to work out of circuits having impedances of from 6,000 to 20,000 ohms.

Type 359E Transformer

Turns ratio (sec. to pri.) 0.025, 0.35, 0.5, 0.7, 1.0, 1.4.

Type 359F Transformer

Turns ratio (sec. to pri.) 0.025, 0.35, 0.5, 0.7, 1.0, 1.4.

Type 359G Auto Transformer

Turns ratio (sec. to pri.) 0.025, 0.35, 0.5, 0.7, 1.4.

Type 359H Auto Transformer

Turns ratio (sec. to pri.) 0.06, 0.09, 0.13, 0.18, 0.23, 0.35.

Types 359E to H inclusive are designed to work out of circuits having impedances of 500 to 600 ohms.

Direct current (primary) resistance all types 400 ohms.

Type 359 Transformers..... Price $15.00

Dimensions 4¼" x 3⅝" x 4½".

The Type 284 transformers are designed for remote control and line amplifier work. Their power rating is 20 watts.

Type 284C Double or Single Microphone to Grid Coupling Transformer.

This transformer is designed for coupling a microphone of either the single or double button type to the grid of the modulator tube.

Type 284D Plate to Telephone Line Coupling Transformer.

A transformer designed to work out of the plate of a vacuum tube into the standard telephone line (500-600 ohms impedance).

Type 284E Telephone Line to Grid Coupling Transformer.

A coupling unit for working out of the low impedance of a telephone line into the high impedance grid circuit of a vacuum tube.

Type 284F Plate to Grid Coupling Transformer.

An interstage coupling transformer for use where good quality is essential. The power rating is double that of our standard Type 285.

Type	Turns Ratio	Impedance Ratio	Resistance (ohms) Pri.	Sec.
284C	1:104	1:10,600	4	14,000
284D	6.3:1	40:1	340	18
284E	1:41	1:1700	18	14,000
284F	1:6.5	1:42.5	340	14,000

Type 284 Transformers ..... Price $12.00

Dimensions 4½" x 3½" x 2¾". Weight 2¼ lbs.

Type 285M Single Microphone to Grid Coupling Transformer.

Similar to the type 284C, but designed for use with a single bottom microphone. The power rating is 10 watts.

Turns ratio 1:44.5. Impedance 1:2000.

Dimensions 3½" x 3¼" x 2½". Weight 1½ lbs.

Type 285M ..... Price $7.00

Type 285T is designed for use between circuits having approximately the same impedance, in the neighborhood of 500 to 600 ohms where it is desired to insulate such circuits from each other, as when direct current flows in one, and is undesirable in the other.

Impedance Ratio 1:1.

Dimensions 3½" x 3¼" x 2½". Weight 1½ lbs.

Type 285T ..... Price $7.00

The Type 285N is designed to adapt the elements of the Type 338 Oscillograph to bridge circuits.

Ratio—Turns 18:1; Impedance 325:1.

Dimensions 3½" x 3¼" x 2½". Weight 1½ lbs.

Type 285N ..... Price $10.00

POWER TRANSFORMERS

Small power transformers are frequently required about the laboratory. The following types are available. The power rating of all types is 60 watts:

Type 273 Transformers ..... Price $12.00

Type 273K.	Pri. 110	Sec. 200—6.5—5	volts
Type 273M.	Pri. 110	Sec. 480—7.5—7.5	volts
Type 273L.	Pri. 110	Sec. 150—7.5—6	volts

Dimensions 3¼" x 3¾" x 3½". Weight 3¾ lbs.

Type 285 0. 110—9.6 volts (10 watts) ..... Price $7.00

Dimensions 3½" x 3½" x 2½". Weight 1½ lbs.

A number of other transformers will be found listed in Bulletin No. 926. They include small power transformers, iron cored chokes, coupling transformers, and filters for use between the plate of various types of vacuum tubes and loudspeakers.

Special transformers, both power and impedance adjusting, may be made to order along the lines of those listed above. The usual price for such special transformers is $15.00 each net.

The Engineering Department of the General Radio Company would be glad to determine specifications for any such transformers designed to serve any particular purpose.

Type 166
TELEPHONE TRANSFORMERS

For many purposes in a laboratory a small iron core transformer of high and adjustable impedance is extremely useful. It may be used to advantage in impedance bridges employing a telephone receiver to detect the balance point. With this transformer it is possible to adjust the impedance of the telephone circuit to the most satisfactory value for the bridge circuit, independent of the telephone receiver impedance.

The winding is all on one leg of the core, but is in two separate parts so as to be used as a primary and secondary. These windings, however, may be connected in series should it be desired to use an auto transformer connection. Taps are brought out on both the primary and secondary windings so that it is possible to vary the impedance and the ratio of transformation. A small air gap is left in the iron core to prevent any possible distortion of wave form due to saturation of the iron. The panel is of bakelite with engraved lettering. Nickel plated binding posts are used as terminals for the taps. The following table shows the number of turns between each set of binding posts:

PRIMARY		SECONDARY	
1-2	150 Turns	5-6	1200 Turns
2-3	300 Turns	6-7	2400 Turns
3-4	600 Turns	7-8	4800 Turns

Type 166 Telephone Transformer $9.00

Dimensions 2¾" x 2½" x 2¼". Weight 2 lbs.

Code Word "TOPIC."

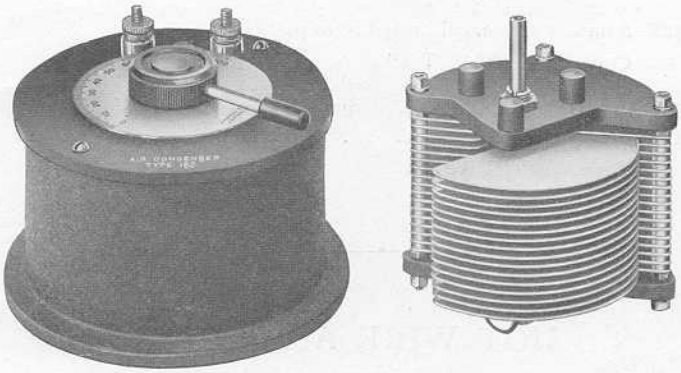
GENERAL RADIO COMPANY

MANUFACTURERS OF

HIGH GRADE RADIO LABORATORY APPARATUS

CAMBRIDGE, MASSACHUSETTS

BULLETIN 901 **JANUARY 1920**



VARIABLE AIR CONDENSER

TYPE 182

The design of this condenser makes it particularly adapted for use in radio oscillating circuits. The plates are cut so as to obtain a nearly uniform wavelength variation throughout the entire range of the condenser. This is particularly valuable in circuits such as those used with vacuum tubes, where the ratio of inductance to capacitance is large. The capacitance at the zero end of the scale is very low, being less than 30 micro-microfarads. The plates are heavier than those of the usual variable condenser of this size, and the end supports are arranged to reduce the usual dielectric losses. The rotary plates are mounted on a steel shaft which runs in two cone brass bearings, which permit of adjustment to any desired degree of turning resistance, and of taking up perfectly any wear which may occur in them after years of service. Electric connection to the rotary plates is accomplished by a special flexible lead, thereby preventing any possibility of varying resistance which might result were the bearings used for this purpose.

The case is of spun metal with our permanent black crystaline finish. The panel is of Bakelite with engraved lettering filled with white.

A small extension handle is provided for accurate adjustment.

This condenser is made in two sizes, of approximately 700 and 1000 micro-microfarads maximum capacitance respectively. The smaller condenser is 5½ inches diameter x 4⅛ inches high and weighs two pounds, while the larger is 5½ inches diameter x 5⅛ inches high and weighs two and one-half pounds.

TYPE 182A	Condenser, Max. Cap. 700 M.M.F. . . . . Code Word "CUDDY"	$12.00
TYPE 182B	Same as above, calibrated at 10 points . . . . . Code Word "CUMIN"	13.50
TYPE 182C	(182A Unmounted) Without case, top, or binding posts, but with scale and handle . . . . . Code Word "CUPID"	8.50
TYPE 182E	Condenser, Max. Cap. 1000 M.M.F. . . . . Code Word "CANDY"	13.50
TYPE 182F	Same as above, calibrated at 10 points . . . . . Code Word "CANTO"	15.00
TYPE 182G	(182E Unmounted) Without case, top, or binding posts, but with scale and handle . . . . . Code Word "CAPER"	9.70

HOT WIRE AMMETERS

TYPE 127

A high-grade hot wire meter should contain three definite qualities — ruggedness of construction, quickness of action, and permanence of operating characteristics In our Type 127 Meter careful design and good workmanship are co-ordinated to produce an instrument which is electrically and mechanically good, and which has found a multiplicity of uses in the electrical art.

The expanding strip in these meters is of thin platinum so as to prevent oxidization. The type of multiplying action is such that a more uniform scale is obtained than with many small hot wire meters. The bearings which support the steel shaft are of finest sapphire, a point which needs no further comment. These meters have been corrected for temperature so that there is very little shift of zero. This type of instrument is equally accurate on direct or alternating current of any frequency.

While the illustration on Page 903 shows only the portable type of instrument, these meters are carried in stock in types suitable for use on switchboards. In mounting the flush type of meter an opening in the panel of 2⅝ in. in diameter should be provided for. In mounting the front-of-board type allowance should be made for the case which is 3 in. in diameter. In addition to the sizes listed these meters can be supplied with maximum range of .1, .25 and .5 ampere.

Range	Case	Code Word	Price
1 Amp.	Portable	Molar	$11.00
2 Amps.	Portable	Monad	11.00
3 Amps.	Portable	Moral	11.00
5 Amps.	Portable	Mummy	11.00
10 Amps.	Portable	Musty	11.00

Dimensions 3 in. x 4 in. x 1½ in. high. Weight 10½ oz.

1 Amp.	Front of Board	Manor	10.00
2 Amps.	Front of Board	Marry	10.00
3 Amps.	Front of Board	Mason	10.00
5 Amps.	Front of Board	Matin	10.00
10 Amps.	Front of Board	Maxim	10.00

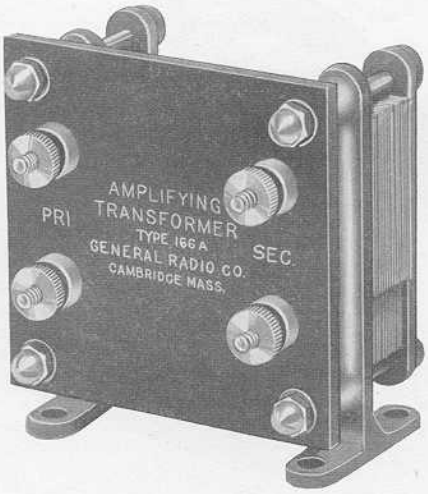
Dimensions 3 in. d. x 1½ in. high. Weight 9 oz.

1 Amp.	Flush Mounting	Merry	10.00
2 Amps.	Flush Mounting	Metal	10.00
3 Amps.	Flush Mounting	Mimic	10.00
5 Amps.	Flush Mounting	Minim	10.00
10 Amps.	Flush Mounting	Minny	10.00

Dimensions 3 in. d. x 1½ in. high. Weight 9½ oz.

For use particularly in wavemeter circuit we can supply this meter uncalibrated, with galvanometer scale of 100 equal divisions, in any type of mounting. The expanding filament will carry .250 milli-amperes and has a resistance of approximately one ohm.

Price $9.00



AMPLIFYING TRANSFORMER

TYPE 166A

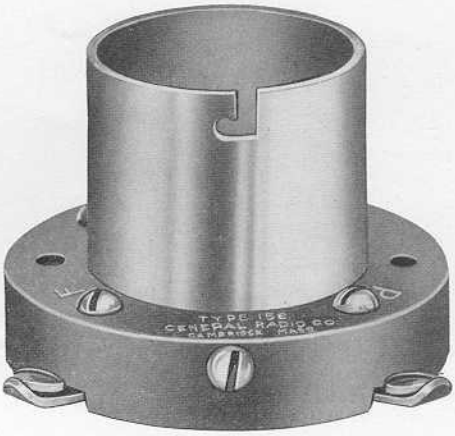
There are many points which must be considered in the design of a satisfactory amplifying transformer. The primary must be capable of receiving the maximum amount of energy while the secondary must deliver this energy undistorted in wave-form, and at the correct potential to the grid circuit of the amplifying tube. Low losses and low distributed capacitance are also very desirable features. These points have been carefully worked out in our type 166A transformer. Special attention has been given to the impedance ratio to make these transformers especially satisfactory for use with tubes having the characteristics of the Western Electric Co. VT-1 and the Marconi Co. Class I and II. The compactness of this instrument greatly adds to its utility.

The panel is of Bakelite, with engraved lettering filled with white. The binding posts and cap nuts are finished in polished nickel. The supports are finished in black enamel.

TYPE 166A Amplifying Transformer $7.00
Dimensions 2¾ in. x 2½ in. x 2¼ in. Weight 1 lb.
Code Word "TALLY"

TYPE 166A Same as above but unmounted 4.50
Dimensions 2½ in. x 2¼ in. x 1½ in. Weight 10 oz.
Code Word "TARDY"

Supports for mounting 75



TUBE SOCKET

TYPE 156

The salient features of this socket are the positive contact springs and its unusually substantial and attractive appearance. The base is of moulded Bakelite, while the tube and terminal screws are of brass with a polished nickel finish. This socket is adapted to any of the standard American four-prong tubes. Transmitting tubes can be used in this socket by simply changing two screws.

TYPE 156 Socket . . . . . Code Word "SOBER" . . . $1.75
Dimensions 2½ in. x 2½ in. x 1¾ in. Weight 4 ozs.

MARCONI VACUUM TUBES

These tubes are released by the Marconi Company and are for experimental use only. They are manufactured under Fleming and DeForest patents. In ordering, specify whether Class I (detector) or Class II (amplifier) tubes are desired.

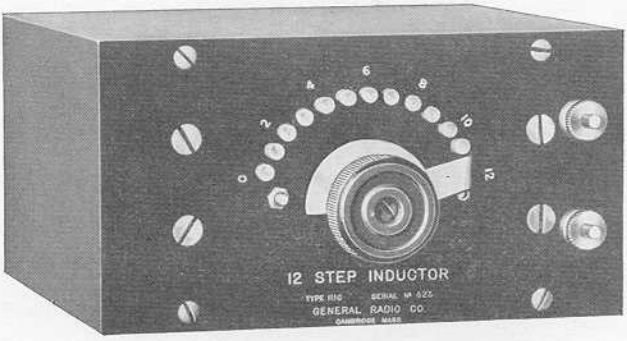
Price each $7.00

WESTERN ELECTRIC HEAD PHONES

TYPE 1002A

This receiver, formerly known as the "P11," was adopted as standard by both the Army and Navy during the war. Combining as it does, sensitivity with great ruggedness, it is unusually well adapted to use in the laboratory and in the receiving station.

Price, complete with cord $12.50



10 STEP INDUCTOR

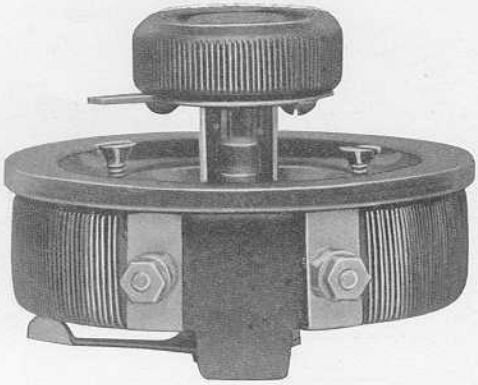
TYPE 111

The value of concentrated inductances for radio work has long been recognized, but it was not until the development of banked and sectionalized windings to reduce distributed capacitance and dead end effects that this type of inductance became possible. The further possibility of obtaining mutual coupling between three or four different circuits, such as is necessary when vacuum tubes are used, makes this type of inductor almost a necessity. By changing the distance between units any desired degree of coupling may be obtained. These inductances are wound in sections, separated from each other, and contained in an oak case with engraved Bakelite panel. The metal parts are finished in polished nickel.

The table given below shows the wavelength at which these inductances will oscillate when used with a condenser of 1000 micro-microfarads capacitance. The approximate resistances of these inductances are respectively 1, 6, 45 and 68 ohms.

Dimensions 8 in. x 7 in. x 4½ in. Weight 4 lbs.

TYPE	MAX. IND. MILLI-HENRYS	WAVE-LENGTH	CODE WORD	PRICE
111C	1	2000	Abbot	$18.00
111D	10	6000	Abhor	18.00
111E	75	17000	Abide	18.00
111F	150	24000	Abyss	18.00



RHEOSTAT

TYPE 214

The above illustration shows the back of panel type; when mounted only the knob and pointer projecting through the panel. Portable type of rheostat can also be supplied. The resistance of this instrument is about 7 ohms and it has a current-carrying capacity of 1.5 amperes. Ruggedness of construction and smoothness of operation make this rheostat especially adapted to laboratory and radio use. It was particularly designed for use in regulating the filament current in vacuum tube circuits. Other resistances up to 400 ohms can be supplied at a slightly increased cost.

Dimensions 3 in. d. x 2¼ in. Weight 7 oz.

TYPE	MOUNTING	CODE WORD	PRICE
214A	Panel	Rural	$2.50
214B	Portable	Rusty	2.50

THE GR BUZZER

TYPE 178

This buzzer has been designed for laboratory and radio use and combines pureness of tone, simplicity of adjustment and durability. The buzzer will operate continuously on one or two dry cells without adjustment. The current drawn is approximately 30 milli amperes.

Dimensions 2 in. x 1¾ in. x 1 in. Weight 3 oz.

TYPE	MOUNTING	CODE WORD	PRICE
178A	Above Panel	Befog	$2.00
178B	Below Panel	Beget	2.00

The products of the General Radio Company are not limited to the instruments listed in this bulletin, but cover a complete line of high frequency radio laboratory apparatus. Information and bulletins of special apparatus will be sent on request. Our line includes the following instruments:

Variable Air Condensers
Vernier Condensers
Standard Condensers
Decade Condensers
Variometers
Standards of Inductance
Standards of Resistance
Decade Resistance Boxes
Wavemeters
Decade Bridge
Capacity Bridge
Slide Wire Bridge
Audibility Meters
Hot Wire Ammeters
Galvanometers
Thermo-Couples
Telephone Transformer

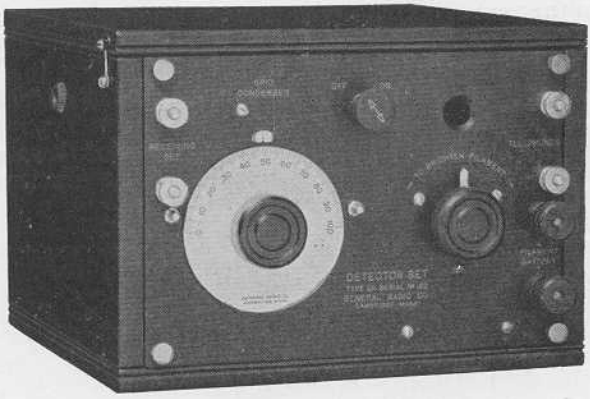
All prices in this catalogue are strictly net, subject to change without notice, F. O. B. Cambridge, Massachusetts. Cash should accompany orders from persons or firms with whom we have not already opened accounts. Unless otherwise instructed we shall use our own judgment regarding method of shipment.

GENERAL RADIO COMPANY

MANUFACTURERS OF
HIGH GRADE RADIO LABORATORY APPARATUS
CAMBRIDGE, MASSACHUSETTS

BULLETIN 902 **MAY 1920**

DETECTOR SET AND AMPLIFIERS



VACUUM TUBE DETECTOR
Type 211

The radio experimenter usually demands that his apparatus be in separate units so that he may change the connections and try out the points of superiority of different circuits. He meets. however, with the limitation, particularly when working at short wavelengths, that his apparatus must be arranged as compactly as possible so that the amount of wiring may be kept at a minimum. These considerations have resulted in the tuning inductances and condensers being kept separate and the instruments of the detector circuit being mounted in one compact unit.

The General Radio Co. Type 211 Vacuum Tube Detector Set has been designed so that the component instruments are mounted in one compact unit, yet are available for any desired circuit changes. The instruments in this set consist of a variable grid condenser, a cartridge type grid leak, filament rheostat, tube socket, filament switch, and the necessary external binding posts. These units which are mounted in a polished oak cabinet with plate battery compartment, are all General Radio Co. standard instruments. The exterior metal parts are finished

in polished nickel. Insulated binding posts, however, are used for the filament battery connection. This is a very desirable feature in that it minimizes the possibility of a short circuit, due to the possible slipping off of a loose lead. The engraved bakelite panel on which all of the units are mounted is held in position by knurled screws and may be readily removed permitting an examination of the separate instruments. Mounted on the hinged cover of the cabinet is a wiring diagram showing all the connections of the set.

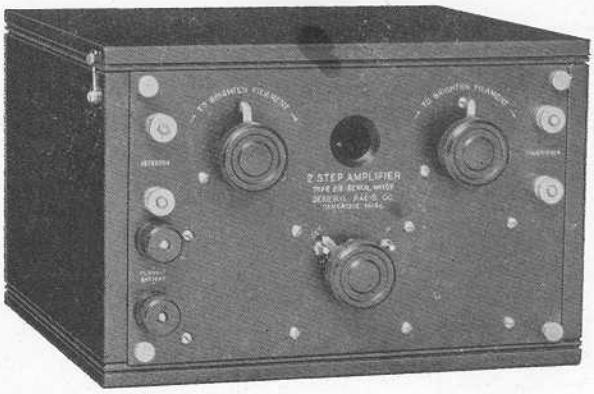
Special attention is called to the fact that a valuable grid condenser and a grid leak are included in this set. They provide a very convenient method of controlling the operation of the tube. This is very essential if the maximum results are to be obtained from the set. A peep hole in the panel is provided so that the brightness of the filament may be observed.

The plate battery compartment is designed so that it will take a single 22 volt battery of the Navy Standard Type. For tubes requiring more than 22 volts the smaller or Signal Corps Type of battery should be used. There is sufficient space for five of these units thus permitting of the use of voltages up to 110. The filament rheostat is adapted for either a 4 or 6 volt battery.

Type 211 Detector Set.....$32.00
Dimensions 9″ x 7″ x 9″. Weight 6½ lbs.
Code Word "DETER."

VACUUM TUBE AMPLIFIERS

Types 206 and 215



Although originally manufactured for laboratory use in connection with sensitive bridge work the General Radio Co. Types 206 and 215 Vacuum Tube Amplifiers have found a wide field in the hands of those radio experimenters who demand only the best. These amplifiers are made in one and two stages. The height and depth of the cabinets is the same as that of the Type 211 Detector Set. This identity in size is very convenient when connecting units together and in addition presents a much neater appearance when units are arranged for a permanent setup. The energy amplification of each stage is approximately 400.

Each amplifier unit consists of an amplifying transformer, tube socket, filament rheostat and control switch, all of which are General Radio Co. standard instruments. The amplifying transformer is our Type 166A, described in Bulletin 901, and which has been so successfully used in many efficient receiving stations. The finish and mounting is similar to that of the Detector Set. A peep hole is provided for observing the vacuum tube filament.

Attention is called to the great flexibility of the two step unit. By means of a single drum switch, constructed to have high insulation resistance and very low electrostatic capacitance, the connections may be shifted so that the amplifier is entirely cut out, one stage only used, or both stages connected. This switch provides positive control including the tube filament circuits; thus when switch is set on "Detector" no amplifier tubes are burning and when set for one stage only one amplifier tube is burning. Complete control from the detector to two stages of amplification is thus provided without the necessity of changing a single connection.

The panels of both the one and two step units are removable so that the wiring and the separate instruments may be readily examined. The covers of the cabinets are hinged, and on each is mounted a wiring diagram showing the complete connections of the set. The plate battery compartment will take the same batteries as the detector unit. The filament rheostat is adapted for either a 4 or 6 volt battery.

Type 206 1 Step Amplifier.....$28.00
Dimensions 8" x 7" x 9". Weight 6¼ lbs.
Code Word "AMPLE."

Type 215 2 Step Amplifier.....$50.00
Dimensions 10" x 7" x 9". Weight 9½ lbs.
Code Word "ANNEX."

The above prices do not include either vacuum tubes or batteries, but we can supply:
Marconi Vacuum Tubes—Class I or Class II.....$7.00
Navy Standard Type Dry Batteries—22 volts.....$2.50

The products of the General Radio Company cover a complete line of high frequency radio laboratory apparatus. Information and bulletins of special apparatus will be sent on request. Our line includes the following: Variable Air Condensers, Vernier Condenser, Standard Condensers, Decade Condensers, Variometers, Standards of Inductance, Standards of Resistance, Decade Resistance Boxes, Wavemeters, Decade Bridge, Capacity Bridge, Slide Wire Bridge, Audubility Meters, Hot Wire Meters, Galvanometers, Thermo-Couples, Telephone Transformer, Miscellaneous Apparatus.

All prices in this bulletin are strictly net, subject to change without further notice, F. O. B. Cambridge, Mass. Cash should accompany orders from persons or firms with whom we have not already opened accounts. Unless otherwise instructed we shall use our own judgment regarding method of shipment.

GENERAL RADIO COMPANY

MANUFACTURERS OF
HIGH GRADE RADIO LABORATORY APPARATUS
CAMBRIDGE, MASSACHUSETTS

BULLETIN 903 **AUGUST 1920**

RATIO ARM BOX
Type 210

For many laboratory measurements such as Wheatstone bridge or impedance bridge measurements, when a complete bridge is not available, it is very convenient to have mounted in one unit suitable resistances which may be used as ratio arms. Such an arrangement is also convenient for comparing capacitances, without the use of a compensating resistance, where errors of the order of one or two per cent are permissible.

The type 210 Ratio Arm Box consists of two similar arms, each with 1000 ohms total resistance, and with intermediate taps at 1-3-10-30-100-300 ohms. The resistances are the Aryton-Perry type, described in our Bulletin 201. They are non-inductive and have very low distributed capacitance. The current carrying capacity is five-hundredths of an ampere. The accuracy of adjustment is 0.1%. These resistance units are mounted in a polished oak box fitted with an engraved bakelite panel. The dial switches are our standard bridge type and have a low and constant resistance.

Type 210 Ratio Arm Box.....$36.00

Dimensions 7½″ x 5″ x 4″. Weight 2¼ lbs.

Code Word "RABID"

UNIVERSAL GALVANOMETER SHUNT
Type 229

When indicating a bridge balance by means of a galvanometer, it is desirable to have a shunt for protecting the galvanometer during the preliminary adjustments. A calibrated shunt is also desirable for extending galvanometer ranges when used for the measurement of small currents. The most convenient type of a galvanometer shunt for general laboratory use is the Aryton-Mather Universal type. The relative multiplying factors of this shunt remain constant for any resistance galvanometer.

Our Type 229 Galvanometer Shunt is arranged in accordance with the Aryton-Mather principle and has a total resistance of 1000 ohms. Taps are arranged to permit a reduction of the galvanometer current to .001-.01-.1 of the maximum. A short circuit point is also provided to give complete protection to the galvanometer when so desired. The control is by means of our standard bridge type of dial switch.

This shunt is mounted in a polished oak box with engraved bakelite panel. Separate pairs of binding posts are provided for the bridge and galvanometer connections.

Type 229 Universal Galvanometer Shunt.....$18.00

Dimensions 5″ x 3½″ x 3½″. Weight 1 lb.

Code Word "GAVOT"

WESTERN ELECTRIC HEAD PHONES
Type 1002-A

Where a sensitive high resistance telephone receiver is used to indicate a bridge balance by the null method we recommend the use of the Western Electric Type 1002-A head phones. This is a double head set complete with adjustable head-band. The resistance per pair is 2200 ohms. These receivers are light, rugged and extremely sensitive. In addition to being adapted to bridge work they are used very extensively in radio receiving sets.

Price complete with cord.....$13.00

TELEPHONE TRANSFORMER
Type 166

For many purposes around a laboratory a small iron core transformer of high and adjustable impedance is extremely useful. It may be used to advantage in impedance bridges employing a telephone receiver to detect the balance point. With this transformer it is possible to adjust the impedance of the telephone circuit to the most satisfactory value for the bridge circuit, independent of the telephone receiver impedance.

The winding is all on one leg of the core but is in two separate parts so as to be used as a primary and secondary. These windings, however, may be connected in series should it be desired to use an auto transformer connection. Taps are brought out on both the primary and secondary windings so that it is possible to vary the impedance and the ratio of transformation. A small air gap is left in the iron core to prevent any possible distortion of waveform due to saturation of the iron. The panel is of bakelite with engraved lettering. Nickel plated binding posts are used as terminals for the taps. The following table shows the number of turns between each set of binding posts.

PRIMARY		SECONDARY	
1-2	150 Turns	5-6	1200 Turns
2-3	300 Turns	6-7	2400 Turns
3-4	600 Turns	7-8	4800 Turns

Type 166 Telephone Transformer.....$9.00

Dimensions 2¾″ x 2½″ x 2¼″. Weight 2 lbs.

Code Word "TOPIC"

MODULATION TRANSFORMER
Type 166M

This transformer is similar in general design to the Type 166 Telephone Transformer. The windings, however, have no intermediate taps as they have already been designed to give the proper ratio of transformation. This transformer is used in radio telephone circuits to increase the grid modulation over that which would be obtained by a direct connection of the telephone transmitter. It is adapted for use with tubes having up to ten watts output. The primary will carry 0.3 ampere continuously.

Type 166M Modulation Transformer.....$7.00
Dimensions 2¾" x 2½" x 2¼". Weight 1 lb.
Code Word "TAPER"

Type 166M. Same as above only unmounted.....$4.50
Code Word "TARRY"

AMPLIFYING TRANSFORMER
Type 166A

Also similar in general design to the Type 166 Telephone Transformer is the Type 166A Amplifying Transformer. Like the Modulation Transformer this instrument has a fixed ratio of transformation. It is designed for coupling vacuum tube circuits for amplifying purposes.

The design of this transformer is such that the primary will receive the maximum amount of energy and deliver it undistorted in waveform at the correct potential to the grid circuit of the amplifying tube. Care has been taken to keep the losses and the distributed capacitance as low as practicable.

The primary has a direct current resistance of approximately 1000 ohms and an impedance of 20,000 ohms at 1000 cycles. For the secondary these values are 5000 and 300,000 ohms respectively. This transformer is illustrated in Bulletin 901.

Type 166A Amplifying Transformer.....$7.00
Dimensions 2¾" x 2½" x 2¼". Weight 1 lb.
Code Word "TALLY"

Type 166A. Same as above only unmounted.....$4.50
Code Word "TARDY"

Supports for mounting..... .75

The products of the General Radio Company cover a complete line of high frequency radio laboratory apparatus. Information and bulletins of special apparatus will be sent on request. Our line includes the following: Variable Air Condensers, Vernier Condenser, Standard Condensers, Decade Condensers, Variometers, Standards of Inductance, Standards of Resistance, Decade Resistance Boxes, Wavemeters, Decade Bridge, Capacity Bridge, Slide Wire-Bridge, Audibility Meters, Hot Wire Meters, Galvanometers, Thermo-Couples, Telephone Transformer, Miscellaneous Apparatus.

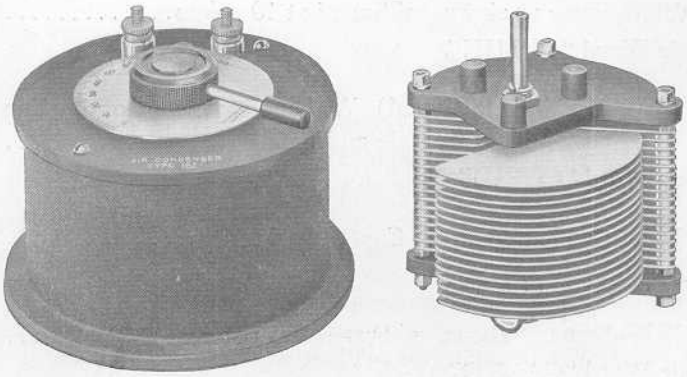
GENERAL RADIO COMPANY

MANUFACTURERS OF

HIGH GRADE RADIO LABORATORY APPARATUS

CAMBRIDGE, MASSACHUSETTS

BULLETIN 904 **DECEMBER, 1920**



VARIABLE AIR CONDENSER
TYPE 182

The design of this condenser makes it particularly adapted for use in radio oscillating circuits. The plates are cut so as to obtain a nearly uniform wavelength variation throughout the entire range of the condenser. This is particularly valuable in circuits such as those used with vacuum tubes, where the ratio of inductance to capacitance is large. The capacitance at the zero end of the scale is very low, being less than 30 micro-microfarads. The plates are heavier than those of the usual variable condenser of this size, and the end supports are arranged to reduce the usual dielectric losses. The rotary plates are mounted on a steeel shaft which runs in two cone brass bearings, which permit of adjustment to any desired degree of turning resistance, and of taking up perfectly any wear which may occur in them after years of service. Electric connection to the rotary plates is accomplished by a special fiexible lead, thereby preventing any possibility of varying resistance which might result were the bearings used for this purpose.

The case is of spun metal with our permanent black crystalline finish. The panel is of bakelite with engraved lettering filled with white.

A small extension handle is provided for accurate adjustment.

This condenser is made in two sizes, of approximately 700 and 1000 micro-microfarads maximum capacitance respectively. The smaller condenser is 5½ inches diameter x 4⅛ inches high and weighs two pounds, while the larger is 5½ inches diameter x 5⅛ inches high and weighs two and one-half pounds.

Type 182A Condenser, Max. Cap. 700 M.M.F. $12.00
Code Word "CUDDY"

Type 182B Same as above, calibrated at 10 points $13.50
Code Word "CUMIN"

Type 182C (182A Unmounted) Without case, top, or binding posts, but with scale and handle $8.50
Code Word "CUPID"

Type 182E Condenser, Max. Cap. 1000 M.M.F. $13.50
Code Word "CANDY"

Type 182F Same as above, calibrated at 10 points $15.00
Code Word "CANTO"

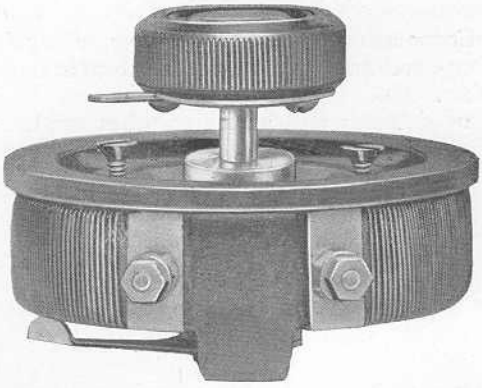
Type 182G (182E Unmounted) Without case, top, or binding posts, but with scale and handle $9.70
Code Word "CAPER"

THE GR BUZZER
TYPE 178

This buzzer has been designed for laboratory and radio use and combines pureness of tone, simplicity of adjustment and durability. The buzzer will operate continuously on one or two dry cells without adjustment. The current drawn is approximately 30 milli amperes.

Dimensions 2 in. x 1¾ in. x 1 in. Weight 3 oz.

Type	Mounting	Code Word	Price
178A	Above Panel	BEFOG	$2.00
178B	Below Panel	BEGET	$2.00



RHEOSTAT
TYPE 214

The above illustration shows the back of panel type; when mounted only the knob and pointer projecting through the panel. Portable type of rheostat can also be supplied. The resistance of this instrument is about 7 ohms and it has a current-carrying capacity of 1.5 amperes. Ruggedness of construction and smoothness of operation make this rheostat especially adapted to laboratory and radio use. It was particularly designed for use in regulating the filament current in vacuum tube circuits.

Dimensions 3 in. d. x 2¼ in. Weight 7 oz.

Type	Mounting	Code Word	Price
214A	Panel	RURAL	$2.50
214B	Portable	RUSTY	$2.50

This rheostat is also supplied in standard sizes of 80 and 350 ohms. Special resistances up to 350 ohms may also be supplied, but the total energy absorbed should not exceed 16 watts. Connection may be made to the switch blade by a third binding post, thus converting the rheostat into an excellent potentiometer useful for biasing grids and for many other purposes.

Price of 80 and 350 ohm sizes.....$3.50
Addition for potentiometer connection.....$ .50

WESTERN ELECTRIC HEAD PHONES
TYPE 1002A

This receiver, formerly known as the "P11," was adopted as standard by both the Army and Navy during the war. Combining as it does, sensitivity with great ruggedness, it is unusually well adapted to use in the laboratory and in the receiving station.

Price, complete with cord.....$15.00

VACUUM TUBES

The Radio Corporation of America is now selling for experimental use vacuum tubes developed by the General Electric Co. We can supply any of these tubes.

Two types of detector and amplifier tubes are now available, the Radiotron UV 200 and Radiotron UV 201. The former is a gas tube and requires an accurate adjustment of the plate voltage for satisfactory detector action. It operates on a single standard 22½ volt plate battery for either detector or amplifier. The latter is a more stable tube than the former and may be used without adjusting the plate voltage. This tube may be used with one or two 22½ volt plate batteries and when used as an amplifier up to five plate batteries may be used with increasing amplification.

For transmiting purposes five watt pliotron tubes requiring plate voltages of 350 are available. Information regarding larger size power tubes will be furnished on request.

Radiotron UV 200 Vacuum tubes.....$5.00
Radiotron UV 201 Vacuum tubes.....$6.50
Pliotron 5 watt transmitting tubes.....$8.00

HOT WIRE AMMETERS TYPE 127

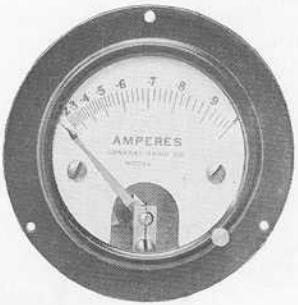
In spark transmitting stations a radiation ammeter is a great convenience; in continuous wave stations it is almost a necessity. It is also desirable to know the filament current of vacuum tubes. This is particularly true of transmitting tubes. The charging rate of storage batteries should be known. These requirements of experimental radio stations make it necessary to possess an ammeter equally accurate on direct currents and on currents of radio frequency. Such a meter should have low impedance. It should be rugged and reliable. The Type 127 Hot Wire Ammeters were built to meet these requirements. During the recent war the U. S. Army and Navy used large numbers of these meters.

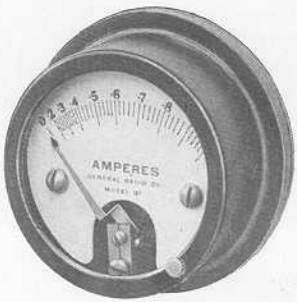
The expanding strip in these meters is of thin platinum, so as to prevent oxidation. It is so proportioned that it works at a low temperature and is of low resistance. These are two highly desirable features, since the former permits reasonable overloading without burning out, and the latter minimizes the losses.

The type of multiplying action is such that a more uniform scale is obtained than with many hot wire meters. These meters have been corrected for temperature so that there is very little shift of zero. Any necessary correction may be made by adjusting a knurled screw.

These instruments are made in three types, the flush mounting for use on panels, the front-of-board mounting for use on switchboards, and the portable type for general use. In mounting the flush type of meter an opening in the panel 2⅝ inches in diameter should be provided. In mounting the front-of-board type allowance should be made for a

case 3 inches in diameter. The flush type meters are mounted in metal cases finished in black japan, while the front-of-board and portable types have cases of moulded bakelite.





TYPE 127A

Range		Code Word	Case	Price
100	Milli-Amps.	MEDAL	Flush Mounting	$9.00
¼	Amp.	MERCY	Flush Mounting	7.75
½	Amp.	MERIT	Flush Mounting	7.75
1	Amp.	MERRY	Flush Mounting	7.75
2.5	Amps.	MINOR	Flush Mounting	7.75
5	Amps.	MINIM	Flush Mounting	7.75
10	Amps.	MINNY	Flush Mounting	7.75
	Galvanometer	MITER	Flush Mounting	7.25

Dimensions 3 in. x 1½ in. Weight 9½ oz.

TYPE 127B

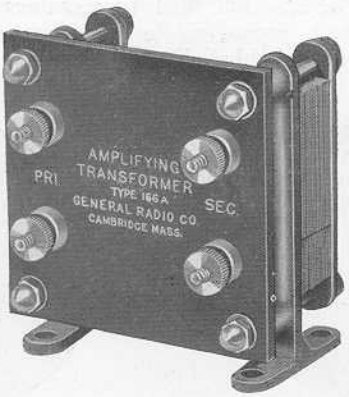
100	Milli-Amps.	MAYOR	Front of Board	9.00
¼	Amp.	MADAM	Front of Board	7.75
½	Amp.	MAJOR	Front of Board	7.75
1	Amp.	MANOR	Front of Board	7.75
2.5	Amps.	MAPLE	Front of Board	7.75
5	Amps.	MATIN	Front of Board	7.75
10	Amps.	MAXIM	Front of Board	7.75
	Galvanometer	MAGIC	Front of Board	7.25

Dimensions 3 in. d. x 1½ in. Weight 9 oz.

TYPE 127C

100	Milli-Amps.	MUGGY	Portable	10.00
¼	Amp.	MOCHA	Portable	9.00
½	Amp.	MOGUL	Portable	9.00
1	Amp.	MOLAR	Portable	9.00
2.5	Amps.	MOTOR	Portable	9.00
5	Amps.	MUMMY	Portable	9.00
10	Amps.	MUSTY	Portable	9.00
	Galvanometer	MOTTO	Portable	8.50

Dimensions 3 in. x 4 in. x 1½ in. Weight 10½ oz.



AMPLIFYING TRANSFORMER
TYPE 166A

There are many points which must be considered in the design of a satisfactory amplifying transformer. The primary must be capable of receiving the maximum amount of energy while the secondary must deliver this energy undistorted in wave-form, and at the correct potential to the grid circuit of the amplifying tube. Low losses and low distributed capacitance are also very desirable features. These points have been carefully worked out in our type 166A transformer. Special attention has been given to the impedance ratio to make these transformers especially satisfactory for use with tubes recently made available for experimental use. The compactness of this instrument greatly adds to its utility.

The primary has a direct current resistance of approximately 1000 ohms and an impedance of 20,000 ohms at 1000 cycles. For the secondary these values are 5000 and 300,000 ohms respectively.

The panel is of bakelite, with engraved lettering filled with white. The binding posts and cap nuts are finished in polished nickel. The supports are finished in black enamel.

Type 166A Amplifying Transformer $7.00
Dimensions 2¾ in. x 2½ in. x 2¼ in. Weight 1 lb.
Code Word "TALLY"

Type 166A Same as above only unmounted.....$4.50
Code Word "TARDY"

Supports for mounting.....$ .75

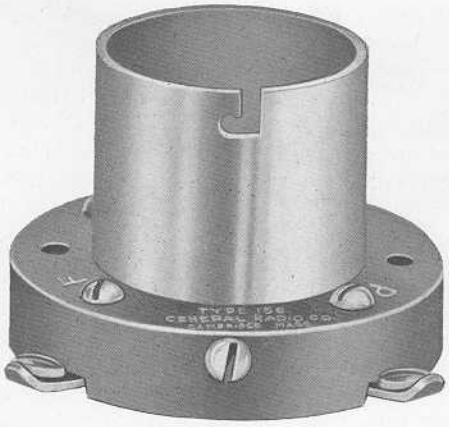
MODULATION TRANSFORMER
TYPE 166M

This transformer is similar in general design to the Type 166A Amplifying Transformer, and is used in radio telephone circuits to increase the grid modulation over that which would be obtained by a direct connection of the telephone transmitter. It is adapted for use with tubes having up to ten watts output. The primary will carry 0.3 ampere continuously.

Type 166M Modulation Transformer $7.00
Dimensions 2¾ in. x 2½ in. x 2¼ in. Weight 1 lb.
Code Word "TAPER"

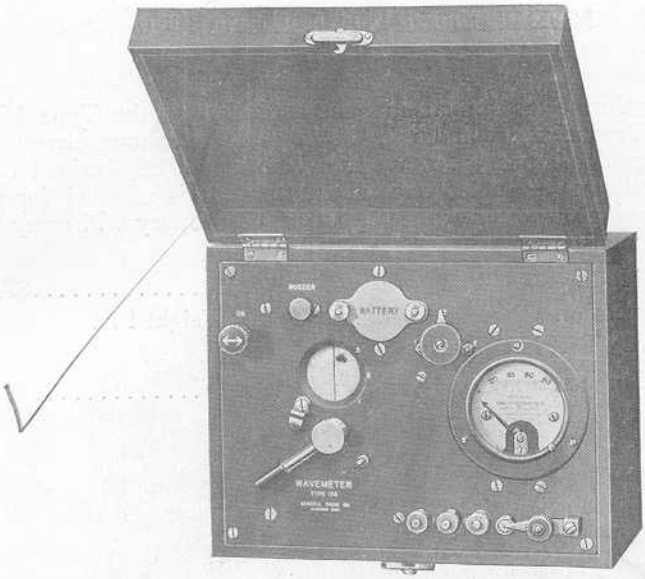
Type 166M Same as above only unmounted.....$4.50
Code Word "TARRY"

TUBE SOCKET
TYPE 156



The salient features of this socket are the positive contact springs and its unusually substantial and attractive appearance. The base is of moulded bakelite, while the tube and terminal screws are of brass with a polished nickel finish. This socket is adapted to any of the standard American four-prong tubes. Transmitting tubes can be used in this socket by simply changing two screws in the socket base.

Type 156 Socket $1.75
Cord Word "SOBER"
Dimensions 2½ in. x 2½ in. x 1¾ in. Weight 4 ozs.



DIRECT READING WAVEMETER
TYPE 174

The above cut illustrates one of the complete line of General Radio Co. wavemeters. This wavemeter is direct reading and has a range of 150-3000 meters. It is complete with hot wire galvanometer, detector, buzzer, battery, and binding posts for telephone attachment.

Information regarding wavemeters for your particular needs will be sent on request.

Type 174 Direct Reading Wavemeter.....$68.00
Cord Word "WITTY"
Dimensions 9 in. x 7 in. x 6 in. Weight 6¾ lbs.

The products of the General Radio Company cover a complete line of high frequency radio laboratory apparatus. Information and bulletins of special apparatus will be sent on request. Our line includes the following: Variable Air Condensers, Vernier Condenser, Standard Condensers, Decade Condensers, Variometers, Standards of Inductance, Standards of Resistance, Decade Resistance Boxes, Wavemeters, Decade Bridge, Capacity Bridge, Slide Wire Bridge, Audibility Meters, Hot Wire Meters, Galvanometers, Thermo-Couples, Telephone Transformer, Miscellaneous Apparatus.

All prices in this bulletin are strictly net, subject to change without notice, F. O. B. Cambridge, Mass. Cash should accompany orders from persons or firms with whom we have not already opened accounts. Unless otherwise instructed we shall use our own judgment regarding method of shipment.

[This Bulletin replaces Bulletin 901]

GENERAL RADIO COMPANY

MANUFACTURERS OF

HIGH GRADE RADIO LABORATORY APPARATUS

CAMBRIDGE, MASSACHUSETTS

BULLETIN 905 **DECEMBER 1920**

RATIO ARM BOX
Type 210

For many laboratory measurements such as Wheatstone bridge or impedance bridge measurements, when a complete bridge is not available, it is very convenient to have mounted in one unit suitable resistances which may be used as ratio arms. Such an arrangement is also convenient for comparing capacitances, without the use of a compensating resistance, where errors of the order of one or two per cent are permissible.

The type 210 Ratio Arm Box consists of two similar arms, each with 1000 ohms total resistance, and with intermediate taps at 1-3-10-30-100-300 ohms. The resistances are the Ayrton-Perry type, described in our Bulletin 204. They are non-inductive and have very low distributed capacitance. The current carrying capacity is five-hundredths of an ampere. The accuracy of adjustment is 0.1%. These resistance units are mounted in a polished oak box fitted with an engraved bakelite panel. The dial switches are our standard bridge type and have a low and constant resistance.

Type 210 Ratio Arm Box $36.00

Dimensions 7½" x 5" x 4". Weight 2¼ lbs.

Code Word "RABID"

UNIVERSAL GALVANOMETER SHUNT
Type 229

When indicating a bridge balance by means of a galvanometer, it is desirable to have a shunt for protecting the galvanometer during the preliminary adjustments. A calibrated shunt is also desirable for extending galvanometer ranges when used for the measurement of small currents. The most convenient type of a galvanometer shunt for general laboratory use is the Ayrton-Mather Universal type. The relative multiplying factors of this shunt remain constant for any resistance galvanometer.

Our Type 229 Galvanometer Shunt is arranged in accordance with the Ayrton-Mather principle and has a total resistance of 1000 ohms. Taps are arranged to permit a reduction of the galvanometer current to .001-.01-.1 of the maximum. A short circuit point is also provided to give complete protection to the galvanometer when so desired. The control is by means of our standard bridge type of dial switch.

This shunt is mounted in a polished oak box with engraved bakelite panel. Separate pairs of binding posts are provided for the bridge and galvanometer connections.

Type 229 Universal Galvanometer Shunt $18.00
Dimensions 5" x 3½" x 3½". Weight 1 lb.
Code Word "GAVOT"

WESTERN ELECTRIC HEAD PHONES
Type 1002-A

Where a sensitive high resistance telephone receiver is used to indicate a bridge balance by the null method we recommend the use of the Western Electric Type 1002-A head phones. This is a double head set complete with adjustable head-band. The resistance per pair is 2200 ohms. These receivers are light, rugged and extremely sensitive. In addition to being adapted to bridge work they are used very extensively in radio receiving sets.

Price complete with cord $15.00

TELEPHONE TRANSFORMER
Type 166

For many purposes in a laboratory a small iron core transformer of high and adjustable impedance is extremely useful. It may be used to advantage in impedance bridges employing a telephone receiver to detect the balance point. With this transformer it is possible to adjust the impedance of the telephone circuit to the most satisfactory value for the bridge circuit, independent of the telephone receiver impedance.

The winding is all on one leg of the core but is in two separate parts so as to be used as a primary and secondary. These windings, however, may be connected in series should it be desired to use an auto transformer connection. Taps are brought out on both the primary and secondary windings so that it is possible to vary the impedance and the ratio of transformation. A small air gap is left in the iron core to prevent any possible distortion of waveform due to saturation of the iron. The panel is of bakelite with engraved lettering. Nickel plated binding posts are used as terminals for the taps. The following table shows the number of turns between each set of binding posts.

PRIMARY		SECONDARY	
1-2	150 Turns	5-6	1200 Turns
2-3	300 Turns	6-7	2400 Turns
3-4	600 Turns	7-8	4800 Turns

Type 166 Telephone Transformer $9.00
Dimensions 2¾" x 2½" x 2¼". Weight 2 lbs.

Code Word "TOPIC"

MODULATION TRANSFORMER
Type 166M

This transformer is similar in general design to the Type 166 Telephone Transformer. The windings, however, have no intermediate taps as they have already been designed to give the proper ratio of transformation. This transformer is used in radio telephone circuits to increase the grid modulation over that which would be obtained by a direct connection of the telephone transmitter. It is adapted for use with tubes having up to ten watts output. The primary will carry 0.3 ampere continuously.

Type 166M Modulation Transformer $7.00
Dimensions 2¾" x 2½" x 2¼". Weight 1 lb.
Code Word "TAPER"

Type 166M Same as above only unmounted $4.50
Code Word "TARRY"

AMPLIFYING TRANSFORMER
Type 166A

Also similar in general design to the Type 166 Telephone Transformer is the Type 166A Amplifying Transformer. Like the Modulation Transformer this instrument has a fixed ratio of transformation. It is designed for coupling vacuum tube circuits for amplifying purposes.

The design of this transformer is such that the primary will receive the maximum amount of energy and deliver it undistorted in waveform at the correct potential to the grid circuit of the amplifying tube. Care has been taken to keep the losses and the distributed capacitance as low as practicable.

The primary has a direct current resistance of approximately 1000 ohms and an impedance of 20,000 ohms at 1000 cycles. For the secondary these values are 5000 and 300,000 ohms respectively. This transformer is illustrated in Bulletin 904.

Type 166A Amplifying Transformer $7.00
Dimensions 2¾" x 2½" x 2¼". Weight 1 lb.
Code Word "TALLY"

Type 166A Same as above only unmounted $4.50
Code Word "TARDY"

Supports for mounting $0.75

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[This Bulletin replaces Bulletin 903]

GENERAL RADIO COMPANY

MANUFACTURERS OF
HIGH GRADE RADIO LABORATORY APPARATUS
CAMBRIDGE, MASSACHUSETTS

BULLETIN 906 **DECEMBER 1920**

DETECTOR SET AND AMPLIFIERS

VACUUM TUBE DETECTOR
Type 211

The radio experimenter usually demands that his apparatus be in separate units so that he may change the connections and try out the points of superiority of different circuits. He meets, however, with the limitation, particularly when working at short wavelengths, that his apparatus must be arranged as compactly as possible so that the amount of wiring may be kept at a minimum. These considerations have resulted in the tuning inductances and condensers being kept separate and the instruments of the detector circuit being mounted in one compact unit.

The General Radio Co. Type 211 Vacuum Tube Detector Set has been designed so that the component instruments are mounted in one compact unit, yet are available for any desired circuit changes. The instruments in this set consist of a variable grid condenser, a cartridge type grid leak, filament rheostat, tube socket, filament switch, and the necessary external binding posts. These units which are mounted in a polished oak cabinet with plate battery compartment, are all General Radio Co. standard instruments.

The exterior metal parts are finished in polished nickel. Insulated binding posts, however, are used for the filament battery connection. This is a very desirable feature in that it minimizes the possibility of a short circuit, due to the possible slipping off of a loose lead. The engraved bakelite panel on which all of the units are mounted is held in position by knurled screws and may be readily removed permitting an examination of the separate instruments. Mounted on the hinged cover of the cabinet is a wiring diagram showing all the connections of the set.

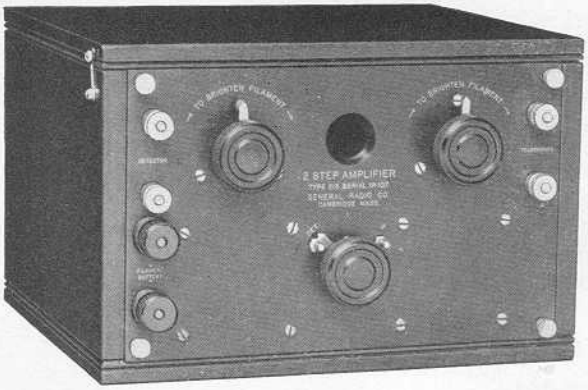
Special attention is called to the fact that a variable grid condenser and a grid leak are included in this set. They provide a very convenient method of controlling the operation of the tube. This is very essential if the maximum results are to be obtained from the set. A peep hole in the panel is provided so that the brightness of the filament may be observed.

The plate battery compartment is designed so that it will take a single 22 volt battery of the Navy Standard Type. For tubes requiring more than 22 volts the smaller or Signal Corps Type of battery should be used. There is sufficient space for five of these units thus permitting the use of voltages up to 110. The filament rheostat is adapted for either a 4 or 6 volt battery.

Type 211 Detector Set $32.00
Dimensions 9 x 9″ x 7″. Weight 6½ lbs.
Code Word "DETER."

VACUUM TUBE AMPLIFIERS

Types 206 and 215



Although originally manufactured for laboratory use in connection with sensitive bridge work the General Radio Co. Types 206 and 215 Vacuum Tube Amplifiers have found a wide field in the hands of those radio experimenters who demand only the best. These amplifiers are made in one and two stages. The height and depth of the cabinets is the same as that of the Type 211 Detector Set. This identity in size is very convenient when connecting units together and in addition presents a much neater appearance when units are arranged for a permanent setup. The energy amplification of each stage is approximately 400.

Each amplifier unit consists of an amplifying transformer, tube socket, filament rheostat and control switch, all of which are General Radio Co. standard instruments. The amplyfiing transformer is our Type 166A, described in Bulletin 904, and which has been so successfully used in many efficient receiving stations. The finish and mounting is similar to that of the Detector Set. A peep hole is provided for observing the vacuum tube filament.

Attention is called to the great flexibility of the two step unit. By means of a single drum switch, constructed to have high insulation resistance and very low electrostatic capacitance, the connections may be shifted so that the amplifier is entirely cut out, one stage only used, or both stages connected. This switch provides positive control including the tube filament circuits; thus when switch is set on "Detector" no amplifier tubes are burning and when set for one stage only one amplifier tube is burning. Complete control from the detector to two stages of amplification is thus provided without the necessity of changing a single connection.

The panels of both the one and two step units are removable so that the wiring and the separate instruments may be readily examined. The covers of the cabinets are hinged, and on each is mounted a wiring diagram showing the complete connections of the set. The plate battery compartment will take the same batteries as the detector unit. The filament rheostat is adapted for either a 4 or 6 volt battery.

Type 206 1 Step Amplifier $28.00
Dimensions 8″ x 7″ x 9 . Weight 6¼ lbs.
Code Word "AMPLE."

Type 215 2 Step Amplifier $50.00
Dimensions 10″ x 7″ x 9″. Weight 9½ lbs.
Code Word "ANNEX."

The above prices do not include either vacuum tubes or batteries, but we can supply:

Radiotron U. V. 201 Vacuum Tubes $6.50

Navy Standard Type Dry Batteries—22 volts $3.50

WESTERN ELECTRIC HEAD PHONES

Type 1002A

This receiver, formerly known as the "P11," was adopted as standard by both the Army and Navy during the war. Combining as it does, sensitivity with great ruggedness, it is unusually well adapted to use in the laboratory and in the receiving station.

Price, complete with cord $15.00

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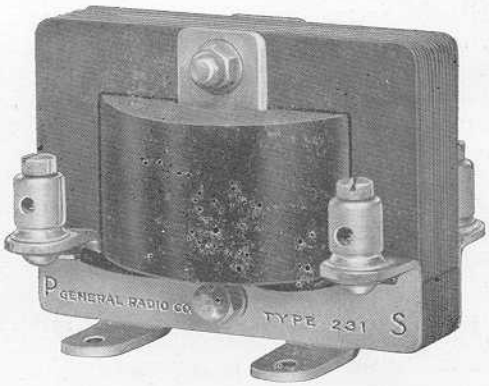
GENERAL RADIO COMPANY

MANUFACTURERS OF

ELECTRICAL AND RADIO LABORATORY APPARATUS

CAMBRIDGE, MASSACHUSETTS

BULLETIN 907 **APRIL 1921**



AMPLIFYING TRANSFORMER
Type 231A

The remarkable results obtained in long distance radio communication in recent years have been due largely to amplification made possible by the use of vacuum tubes. The experimenter has been at a decided disadvantage, due to his inability to get suitable vacuum tubes. Fortunately, this question has now been settled and satisfactory tubes are available.

In order to get the maximum of results from these tubes as amplifiers, they must be used with correctly designed amplifying transformers. Our Type 231A transformer was built specifically to meet this situation. The primary receives the maximum amount of energy and delivers it undistorted in waveform and at the correct potential to the grid of the amplifying tube.

The core construction is such that there is little tendency for the setting up of external fields, with the resultant howling in the audio frequency circuit. The distributed capacity of the secondary is low, so that the maximum potential is obtained on the grid of the tube.

The primary has a direct current resistance of 1,100 ohms, an alternating current resistance at 1000 cycles of 11,000 ohms, and a reactance at this frequency of 66,000 ohms. These figures for the secondary are 5,500, 130,000 and 700,000 ohms respectively.

In order to obtain the best results from an amplifying transformer, certain precautions should be observed. Since what is wanted is the production of the maximum potential, or rather change of potential on the grid of the amplifying tube, it is best to connect the grid to the

outside terminal of the secondary of the transformer. This is because the outer portion of the secondary has smaller capacity to ground than the inner portion, due to the proximity of the latter to the primary winding, which is connected to the filament and other low potential parts of the circuit. This capacity effect increases with frequency and therefore reduces the intensity of high notes proportionately more than low ones, thus tending to cause distortion. Howling, or oscillation at audio frequencies, is caused by coupling (either electrostatic or magnetic) of the amplifier grid to some other part of the circuit, and is more troublesome with two or more stages of amplification than with one. If the electrostatic and magnetic couplings are made to oppose each other, the tendency to oscillate is minimized, and when a transformer is connected into a circuit it is worth while to reverse the leads to the primary to see which connection is better. In some cases, the oscillations are above audibility, but the strength of signals is reduced, nevertheless.

In an oscillating detector circuit the capacity of the telephone cords (which is of the order of 75 M.M.F.) is often sufficient to by-pass the radio frequency current around the high inductance of the phones, but when the primary of an amplifying transformer is substituted for the phones, it should be shunted with a condenser of a few hundred micro-microfarads or more.

Aside from its excellent electrical characteristics, this transformer is well designed mechanically. It is compact, and by means of the four projecting feet, each with a screw hole, may be mounted in any position. The core and coil are finished in black, while the brackets and binding posts are nickeled. Particular attention is called to the accessibility of both the binding posts and the mounting brackets.

Type 231A Amplifying Transformer.....$5.00
Dimensions 2⅝" x 2½" x 2½". Weight, 1 lb.
Code Word: "TUTOR."

MODULATION TRANSFORMER
Type 231M

This transformer is similar in general design to the Type 231A amplifying transformer, the only difference being in the winding. Its windings have been designed particularly for use with the Radiotron UV-202 five-watt transmitting tubes and other tubes of similar characteristics. To get the maximum modulation, the modulating device should have an impedance somewhat greater than the input impedance of the tube. This impedance is of the order of several hundred thousand ohms, while that of a telephone transmitter is but a few ohms. A modulation transformer serves to adapt the telephone transmitter impedance to that of the input circuit of the tube. The success of a radio telephone installation depends not only on the value of the antenna current, but also on how completely that current is modulated. Our Type 231M transformer has been designed to give the maximum modulation which is possible without distortion.

Type 231M. Modulation Transformer.....$5.00
Dimensions 2⅝" x 2½" x 2½". Weight, 1 lb.
Code Word: "TUNIC."

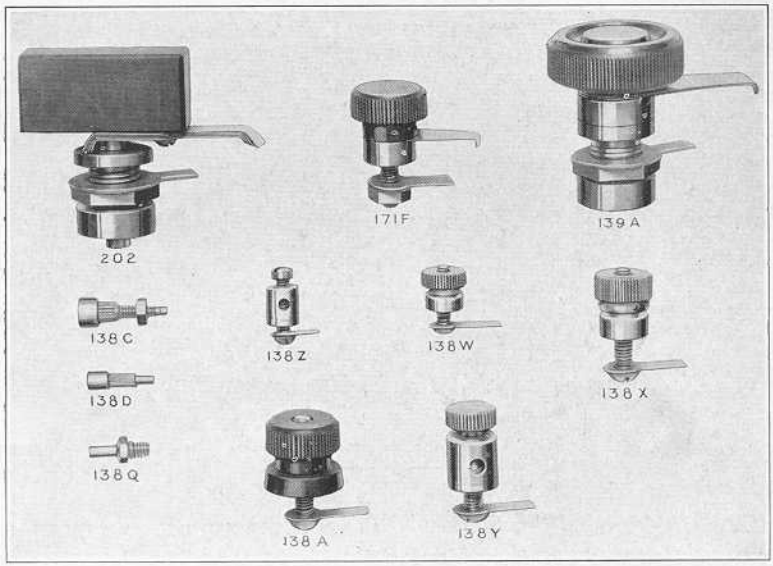
GENERAL RADIO COMPANY

MANUFACTURERS OF

ELECTRICAL AND RADIO LABORATORY APPARATUS

CAMBRIDGE, MASSACHUSETTS

BULLETIN 908 **MAY 1921**



Experimental work frequently requires that the experimenter build special pieces of apparatus in his own laboratory. When this apparatus is of a permanent or semi-permanent nature, it is desirable to have the binding posts, switches and other parts of the best quality, and to have them match instruments already installed. Consequently, we are now listing many of the standard parts used in the assembly of our own instruments.

BINDING POSTS

Type	Description	Screw Size	Price
138A	Insulated	10-32	$0.40
138W	Nickel Plated Brass	6-32	0.15
138X	" " "	10-32	0.18
138Y	" " "	10-32	0.18
138Z	" " "	6-32	0.10

SWITCHES AND PARTS

Type	Description	Price
139A	Multiple Leaf Switch 1⅜" radius	$0.95
171F	Single Leaf Switch ⅞" radius	0.40
202	Low Contact Resistance Switch 1⅜" radius	1.25
138C	$\frac{5}{16}$" Contact for 139A or 202 Switches	0.05
138D	$\frac{3}{16}$" Contact for 171F Switch	0.04
138Q	Switch Stop	0.05

DIALS AND KNOBS

137D	Moulded Knob (same as used on 182 Condenser)	0.40
3"	Metal Dial (same as used on 182 Condenser)	0.50
137D	Knob and 3" Dial Mounted	1.00
137EX	Extension Handle (same as used on 182 Condenser)	0.35
139SN	Small Indicator Button (same as used on 182 Condenser)	0.15
3"	Dial, Complete with Knob, Extension Handle and Indicator Button	1.50
137F	Moulded Knob (same as used on 101 Condenser)	0.90
4"	Dial (same as used on 101 Condenser)	0.75
137F	Knob and 4" Dial Mounted	1.85
101EX	8" Extension Handle for 137 F Knob	1.50
139LN	Large Indicator Button (same as used on 101 Condenser)	0.15
4"	Dial, Complete with Knob, Extension Handle and Indicator Button	3.50

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The coils are approximately of Maxwellian shape. The winding is such as to keep the distributed capacitance a minimum. This is a particularly important feature in that it increases the range over which any one coil may be used, and what is more important, it increases the efficiency of the coil by keeping the dielectric losses a minimum. These coils, are rugged in construction and attractive in appearance. The case is of polished oak with engraved bakelite panel. The metal parts are finished in polished nickel.

One very distinctive feature about these coils is that they are self-supporting and, accordingly, do not require any auxiliary mounting. Coupling between coils is varied by simply changing the distance between coils or by turning through any desired angle. The arrangement of taps is such as to give values of approximately 20%, 45%, 75%and 100% of the maximum inductance.

These coils are adapted for general laboratory use as well as for radio receiving sets. It is seldom necessary to use a complete set of twelve coils to cover all ranges from 150 to above 20,000 meters. A satisfactory arrangement for this range is the following selection:

3 A Coils, 3 C Coils and 3 D Coils.

The ranges covered by these coils when used with one of our type 247 Condensers, which has a maximum capacitance of 1000 micromicrofards, are shown in the following table:

Type	Max. Ind.	Resistance	Approximate Range	Code Word	Price
226A	0.3 M.H.	0.8 Ohm	140- 1000 meters	IMAGE	$6.00
226B	3.0 M.H.	0.9 Ohm	400- 3000 meters	IMBED	$6.00
226C	20.0 M.H.	2.5 Ohms	1100- 8000 meters	IMBUE	$6.00
226D	125.0 M.H.	30.0 Ohms	3000-22000 meters	IMPEL	$6.00

Dimensions 5" x 6" x 1½". Weight 2½ lbs.

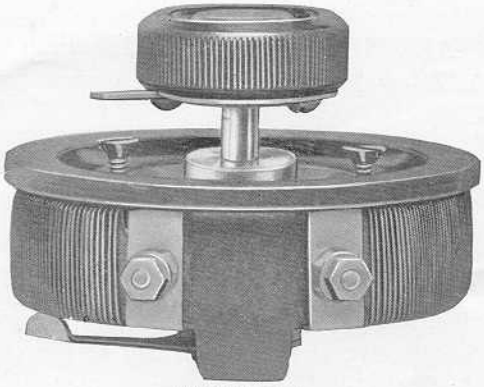
VACUUM TUBES

The Radio Corporation of America is now selling for experimental use several types of vacuum tubes developed by the General Electric Co. We can supply the following tubes.

Radiotron UV200	$5.00
Radiotron UV201	$6.50
Radiotron UV202	$8.00

The UV200 is a gas content detector and amplifier tube and should have an accurate adjustment of the plate voltage, which is approximately 20. The UV201 is a more stable tube than the UV200 and does not require an accurate adjustment of the plate voltage. It will operate on one or two 22½ volt plate batteries and when used as an amplifier up to five batteries may be used with increasing amplification. The UV202 tubes are five watt oscillators requiring plate voltages of 350.

The UV200 and 201 tubes require filament voltages of 5 and currents of 1 ampere. The filament voltage of the UV202 tube is 7.5 and the current 2.35 amperes.



TYPE 214
RHEOSTAT

The Type 214 Rheostat is a convenient, practical instrument for experimental service or for permanent installations. It is made in two types, 214A for back of panel mounting, and 214B for front of panel mounting and portable use. The illustration shows the back of panel type. In this type when mounted, only the knob and pointer project through the panel. The shaft may be adjusted for any thickness of panel up to ⅜". Ruggedness of construction and smoothness of operation make this rheostat especially adapted for laboratory and radio use. There is no grating or clicking of the contact arm.

This rheostat is made for three general classes of service. The first type is for the regulation of receiving tube filament currents. This rheostat has a resistance of 7 ohms and a current carrying capacity of 1.5 amperes. The second type is for the regulation of filament currents of 5 watt transmitting tubes. This rheostat has a resistance of 2 ohms and a carrying capacity of 2.5 amperes. It is sufficient for the regulation of a Radiotron UV202 tube on as high as a 12 volt supply source.

The third type of rheostat is the high resistance type. It is carried in stock in resistances of 80 and 400 ohms with current carrying capacities of 0.3 and 0.1 amperes respectively. When equipped with a third binding post with connection to the switch blade, this rheostat makes a very excellent potentiometer for biasing grids of detector tubes and for other purposes.

Dimensions 3" d. x 2¼". Weight 7 oz.

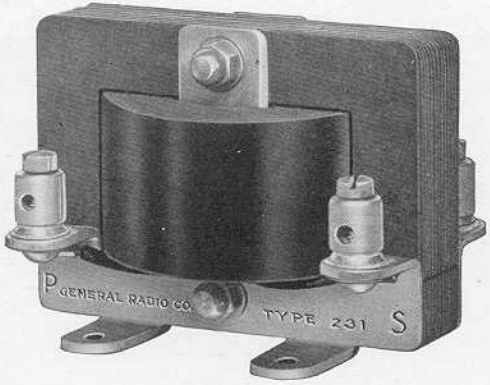
Resistance	Current	Code Word Type 214A	Code Word Type 214B	Price
2 ohms	2.5 amp.	RUDDY	RUMOR	$2.50
7 ohms	1.5 amp.	RURAL	RUSTY	$2.50
80 ohms	0.3 amp.	REVEL	RIFLE	$3.50
400 ohms	0.1 amp.	RIGID	RIVAL	$3.50
80 ohms	Potentiometer	RIVET	ROMAN	$4.00
400 ohms	Potentiometer	ROSIN	ROWEL	$4.00

Special resistances up to 400 ohms may also be supplied, but the total energy absorbed should not exceed 16 watts.

Type 231A
AMPLIFYING TRANSFORMER

The remarkable results obtained in long distance radio communication in recent years have been due largely to amplification made possible by the use of vacuum tubes. The experimenter has been at a decided disadvantage, due to his inability to get suitable vacuum tubes. Fortunately, this question has now been settled and satisfactory tubes are available.

In order to get the maximum of results from these tubes as amplifiers, they must be used with correctly designed amplifying transformers. Our Type 231A transformer was built specifically to meet this situation. The primary receives the maximum amount of energy and delivers it undistorted in waveform and at the correct potential to the grid of the amplifying tube.



The core construction is such that there is little tendency for the setting up of external fields, with the resultant howling in the audio frequency circuit. The distributed capacity of the secondary is low, so that the maximum potential is obtained on the grid of the tube.

The primary has a direct current resistance of 1,100 ohms, an alternating current resistance at 1,000 cycles of 11,000 ohms, and a reactance at this frequency of 66,000 ohms. These figures for the secondary are 5,500, 130,000 and 700,000 ohms respectively.

In order to obtain the best results from an amplifying transformer, certain precautions should be observed. Since what is wanted is the production of the maximum potential, or rather change of potential on the grid of the amplifying tube, it is best to connect the grid to the outside terminal of the secondary of the transformer. This is because the outer portion of the secondary has smaller capacity to ground than the inner portion, due to the proximity of the latter to the primary winding, which is connected to the filament and other low potential parts of the circuit. This capacity effect increases with frequency and therefore reduces the intensity of high notes proportionately more than

low ones, thus tending to cause distortion. Howling, or oscillation at audio frequencies, is caused by coupling (either electrostatic or magnetic) of the amplifier grid to some other part of the circuit, and is more troublesome with two or more stages of amplification than with one. If the electrostatic and magnetic couplings are made to oppose each other, the tendency to oscillate is minimized, and when a transformer is connected into a circuit it is worth while to reverse the leads to the primary to see which connection is better. In some cases, the oscillations are above audibility, but the strength of signals is reduced, nevertheless.

In an oscillating detector circuit the capacity of the telephone cords (which is of the order of 75 M.M.F.) is often sufficient to by-pass the radio frequency current around the high inductance of the phones, but when the primary of an amplifying transformer is substituted for the phones, it should be shunted with a condenser of a few hundred micro-microfarads or more.

Aside from its excellent electrical characteristics, this transformer is well designed mechanically. It is compact, and by means of the four projecting feet, each with a screw hole, may be mounted in any position. The core and coil are finished in black, while the brackets and binding posts are nickeled. Particular attention is called to the accessibility of both the binding posts and the mounting brackets.

Type 231A Amplifying Transformer $5.00

Dimensions 2⅝" x 2½" x 2½". Weight 1 lb.

Code Word : "TUTOR."

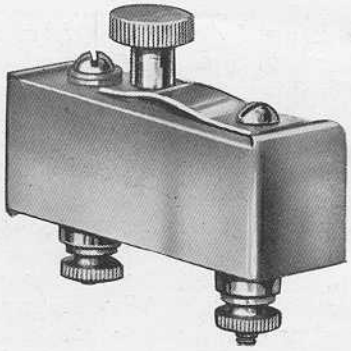
Type 231M
MODULATION TRANSFORMER

This transformer is similar in general design to the Type 231A amplifying transformer, the only difference being in the winding. Its windings have been designed particularly for use with the Radiotron UV-202 five-watt transmitting tubes and other tubes of similar characteristics. To get the maximum modulation, the modulating device should have an impedance somewhat greater than the input impedance of the tube. This impedance is of the order of several hundreds thousand ohms, while that of a telephone transmitter is but a few ohms. A modulation transformer serves to adapt the telephone transmitter impedance to that of the input circuit of the tube. The success of a radio telephone installation depends not only on the value of the antenna current, but also on how completely that current is modulated. Our Type 231M transformer has been designed to give the maximum modulation which is possible without distortion.

Type 231M Modulation Transformer $5.00

Dimensions 2⅝" x 2½" x 2½". Weight, 1 lb.

Code Words: "TUNIC."



TYPE 178
HIGH FREQUENCY BUZZER

This buzzer has been designed for both laboratory and radio use. It combines pureness of tone, simplicity of adjustment and durability.

The frequency is approximately 800 cycles, but depends on the setting of the knurled adjusting screw. As the current required for the operation of the buzzer is approximately only 30 milli-amperes, it may be operated for long periods of time from small batteries. One dry cell will provide sufficient potential to operate this buzzer satisfactorily.

One of the noteworthy features of this buzzer is its freedom from sparking. This is important where pure tones are required. This feature makes the buzzer particularly adapted as a supply source for bridge measurements and for continuous wave telegraph modulation.

Dimensions 2" x 1¾" x 1". Weight 3 oz.

Type	Mounting	Code Word	Price
178A	Above Panel	BEFOG	$2.00
178B	Below Panel	BEGET	$2.00

TYPE 1002A
WESTERN ELECTRIC HEAD PHONES

This receiver, formerly known as the "P11," was adopted as standard by both the Army and Navy during the war. Combining as it does, sensitivity with great ruggedness, it is unusually well adapted to use in the laboratory and in the receiving station.

Price, complete with cord..... $15.00

TYPE 174
DIRECT READING WAVEMETER

The Type 174 Wavemeter is designed for general use in commercial and experimental stations. Its equipment is such that it is adapted for use with receiving and transmitting apparatus employing either damped or undamped waves. It is self-contained and direct reading, features which make the instrument particularly valuable for commercial work.

A hot wire galvanometer is used for indicating resonance of transmitted signals, while for received signals a crystal detector and binding posts for telephones are provided. For producing damped oscillations of known wavelengths, the wavemeter is equipped with a high frequency buzzer.

The oscillating circuit consists of three coils with a selector switch and a variable air condenser. This combination gives a wavelength range of 130-3000 meters.

Particular care has been given to the mechanical construction and to the appearance of this instrument. All of the equipment is mounted on a bakelite panel and enclosed in a polished walnut carrying case. The metal parts are finished in polished nickel.

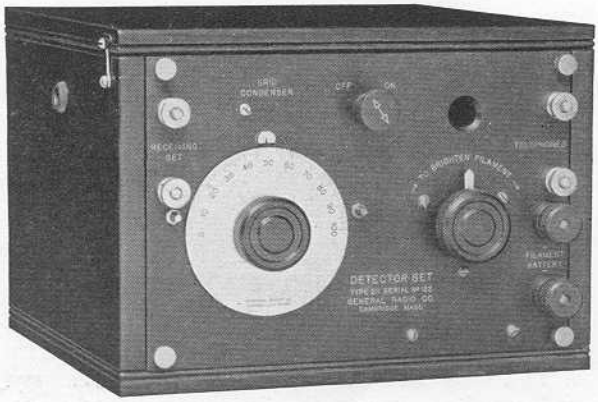
Type 174 Direct Reading Wavemeter $68.00

Code Word: "WITTY."

Dimensions 9" x 7" x 6". Weight 6¾ lbs.

Type 211
VACUUM TUBE DETECTOR

The radio experimenter usually demands that his apparatus be in separate units so that he may change the connections and try out the points of superiority of different circuits. He meets, however, with the limitation, particularly when working at short wavelengths, that his apparatus must be arranged as compactly as possible so that the amount of wiring may be kept at a minimum. These considerations have resulted in the tuning inductances and condensers being kept separate and the instruments of the detector circuit being mounted in one compact unit.



The General Radio Co. Type 211 Vacuum Tube Detector Set has been designed so that the component instruments are mounted in one compact unit, yet are available for any desired circuit changes. The instruments in this set consist of a variable grid condenser, a cartridge type grid leak, filament rheostat, tube stocket, filament switch, and the necessary external binding posts. These units which are mounted in a polished oak cabinet with plate battery compartment, are all General Radio Co. standard instruments.

The exterior metal parts are finished in polished nickel. Insulated binding posts, however, are used for the filament battery connection. This is a very desirable feature in that it minimizes the possibility of a short circuit, due to the possible slipping off of a loose lead. The engraved bakelite panel on which all of the units are mounted is held in position by knurled screws and may be readily removed permitting an examination of the separate instruments. Mounted on the hinged cover of the cabinet is a wiring diagram showing all the connections of the set.

Special attention is called to the fact that a variable grid condenser and a grid leak are included in this set. They provide a very convenient method of controlling the operation of the tube. This is very essential if the maximum results are to be obtained from the set. A peep hole in the panel is provided so that the brightness of the filament may be observed.

The plate battery compartment is designed so that it will take a single 22 volt battery of the Navy Standard Type. For tubes requiring more than 22 volts the smaller or Signal Corps Type of battery should be used. There is sufficient space for five of these units thus permitting the use of voltages up to 110. The filament rheostat is adapted for either a 4 or 6 volt battery.

Type 211 Detector Set $32.00

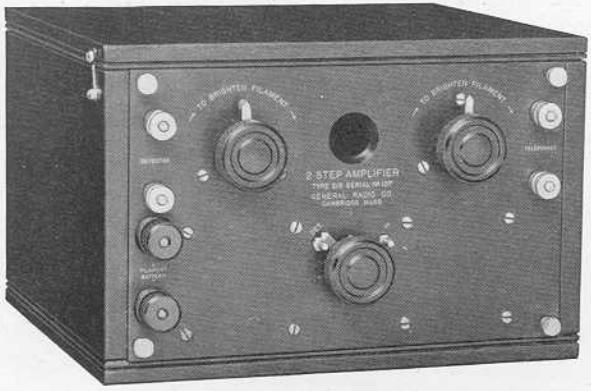
Dimensions 9 x 9" x 7". Weight 6½ lbs.

Code Word: "DETER."

VACUUM TUBE AMPLIFIERS
Types 206 and 215

Although originally manufactured for laboratory use in connection with sensitive bridge work the General Radio Co. Types 206 and 215 Vacuum Tube Amplifiers have found a wide field in the hands of those radio experimenters who demand only the best. These amplifiers are made in one and two stages. The height and depth of the cabinets is the same as that of the Type 211 Detector Set. This identity in size is very convenient when connecting units together and in addition presents a much neater appearance when units are arranged for a permanent setup. The energy amplification of each stage is approximately 400.

Each amplifier unit consists of an amplifying transformer, tube socket, filament rheostat and control switch, all of which are General Radio Co. standard instruments. The amplifying transformer is our Type 231A, described in this Bulletin, and which has been so successfully used in many efficient receiving stations. The finish and mounting is similar to that of the Detector Set. A peep hole is provided for observing the vacuum tube filament.



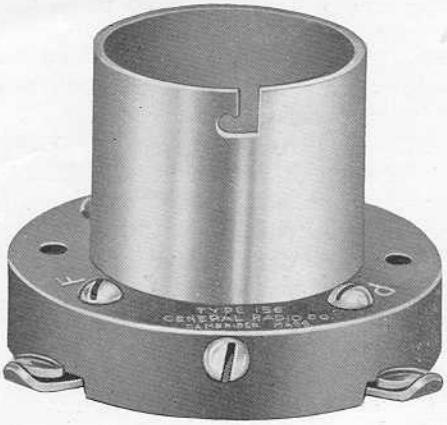
Attention is called to the great flexibility of the two step unit. By means of a single drum switch, constructed to have high insulation resistance and very low electrostatic capacitance, the connections may be shifted so that the amplifier is entirely cut out, one stage only used, or both stages connected. This switch provides positive control including the tube filament circuits; thus when switch is set on "Detector" no amplifier tubes are burning and when set for one stage only one amplifier tube is burning. Complete control from the detector to two stages of amplification is thus provided without the necessity of changing a single connection.

The panels of both the one and two step units are removable so that the wiring and the separate instruments may be readily examined. The covers of the cabinets are hinged, and on each is mounted a wiring diagram showing the complete connections of the set. The plate battery compartment will take the same batteries as a detector unit. The filament rheostat is adapted for either a 4 or 6 volt battery.

Type 206 1 Step Amplifier $28.00
Dimensions 8" x 7" x 9. Weight 6¼ lbs.
Code Word: "AMPLE."

Type 215 2 Step Amplifier $50.00
Dimensions 10" x 7" x 9". Weight 9½ lbs.
Code Word: "ANNEX."

The above prices do not include either vacuum tubes or batteries.



TYPE 156
VACUUM TUBE SOCKET

The salient features of this socket are its positive contact springs and its unusually substantial and attractive appearance. The base is of molded bakelite, while the tube and terminals are of brass with a polished nickel finish. This socket is adapted to any of the standard American four-prong tubes. The springs are heavy enough to carry, without arcing, the filament current of the five watt oscillator tubes.

To accommodate transmitting tubes which have the locating pin placed 45 degrees away from the position standardized for receiving tubes, it is only necessary to turn the socket tube through 45 degrees. Two adjusting screws are provided for locking the tube in either position. This is a universal socket of excellent workmanship.

Type 156 Socket $1.50

Code Word: "SOBER."

Dimensions 2½" x 2½" x 1¾". Weight 4 oz.

TYPE 127
HOT WIRE AMMETERS

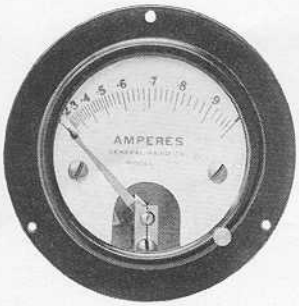
In spark transmitting stations a radiation ammeter is a great convenience; in continuous wave stations it is almost a necessity. It is also desirable to know the filament current of vacuum tubes. This is particularly true of transmitting tubes. The charging rate of storage batteries should be known. These requirements of experimental radio stations make it necessary to possess an ammeter equally accurate on direct currents and on currents of radio frequency. Such a meter should have low impedance. It should be rugged and reliable. The Type 127 Hot Wire Ammeters were built to meet these requirements. During the recent war the U. S. Army and Navy used large numbers of these meters.

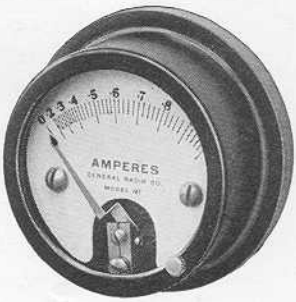
The expanding strip in these meters is of thin platinum, so as to prevent oxidation. It is so proportioned that it works at a low temperature and is of low resistance. These are two highly desirable features, since the former permits reasonable overloading without burning out, and the latter minimizes the losses.

The type of multiplying action is such that a more uniform scale is obtained than with many hot wire meters. These meters have been corrected for temperature so that there is very little shift of zero. Any necessary correction may be made by adjusting a knurled screw.

These instruments are made in three types, the flush mounting for use on panels, the front-of-board mounting for use on switchboards, and the portable type for general use. In mounting the flush type of meter an opening in the panel 2⅝ inches in diameter should be provided.

In mounting the front-of-board type allowance should be made for a case 3 inches in diameter. The flush type meters are mounted in metal cases finished in black japan, while the front-of-board and portable types have cases of moulded bakelite.





TYPE 127A

Range		Code Word	Case	Price
100	Milli-Amps.	MEDAL	Flush Mounting	$9.00
¼	Amp.	MERCY	Flush Mounting	7.75
½	Amp.	MERIT	Flush Mounting	7.75
1	Amp.	MERRY	Flush Mounting	7.75
2.5	Amps.	MINOR	Flush Mounting	7.75
5	Amps.	MINIM	Flush Mounting	7.75
10	Amps.	MINNY	Flush Mounting	7.75
	Galvanometer	MITER	Flush Mountaing	7.25

Dimensions 3 in. x 1½ in. Weight 9½ oz.

TYPE 127B

100	Milli-Amps.	MAYOR	Front of Board	9.00
¼	Amp.	MADAM	Front of Board	7.75
½	Amp.	MAJOR	Front of Board	7.75
1	Amp.	MANOR	Front of Board	7.75
2.5	Amps.	MAPLE	Front of Board	7.75
5	Amps.	MATIN	Front of Board	7.75
10	Amps.	MAXIM	Front of Board	7.75
	Galvanometer	MAGIC	Front of Board	7.25

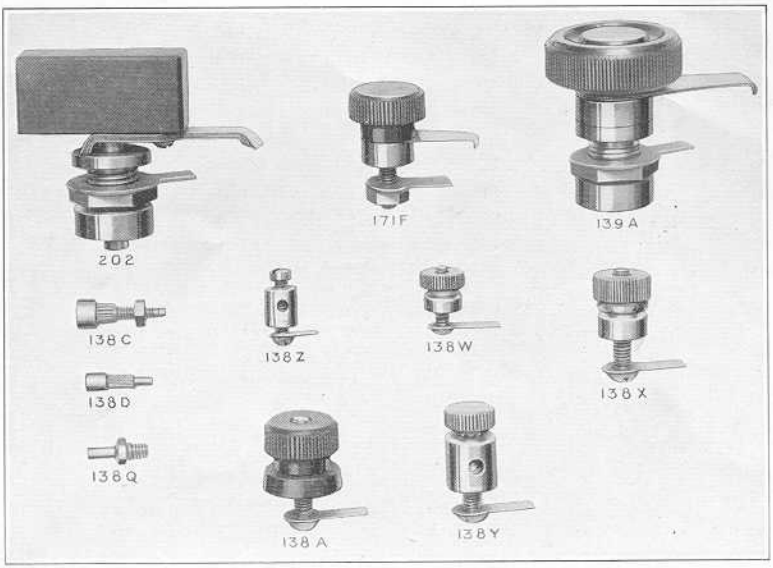
Dimensions 3 in. d. x 1½ in. Weight 9 oz.

TYPE 127C

100	Milli-Amps.	MUGGY	Portable	10.00
¼	Amp.	MOCHA	Portable	9.00
½	Amp.	MOGUL	Portable	9.00
1	Amp.	MOLAR	Portable	9.00
2.5	Amps.	MOTOR	Portable	9.00
5	Amps.	MUMMY	Portable	9.00
10	Amps.	MUSTY	Portable	9.00
	Galvanometer	MOTTO	Portable	8.50

Dimensions 3 in. x 4 in. x 1½ in. Weight 10½ oz.

STANDARD PARTS



Experimental work frequently requires that the experimenter build special pieces of apparatus in his own laboratory. When this apparatus is of a permanent or semi-permanent nature, it is desirable to have the binding posts, switches and other parts of the best quality, and to have them match instruments already installed. Consequently, we are now listing many of the standard parts used in the assembly of our own instruments.

BINDING POSTS

Type	Description	Screw Size	Price
138A	Insulated	10-32	$0.40
138W	Nickel Plated Brass	6-32	0.15
138X	" " "	10-32	0.18
138Y	" " "	10-32	0.18
138Z	" " "	6-32	0.10

SWITCHES AND PARTS

Type	Description	Price
139A	Multiple Leaf Switch 1⅜" radius	$0.95
171F	Single Leaf Switch ⅞" radius	0.40
202	Low Contact Resistance Switch 1⅜" radius	1.25
138C	5/16" Contact for 139A or 202 Switches	0.05
138D	3/16" Contact for 171F Switch	0.04
138Q	Switch Stop	0.05

DIALS AND KNOBS

137D	Moulded Knob (same as used on 239 Condenser)	0.40
3″	Metal Dial (same as used on 239 Condenser)	0.50
137D	Knob and 3″ Dial Mounted	1.00
137EX	Small Extension Handle	0.35
139SN	Small Indicator Button (same as used on 239 Condenser)	0.15
3″	Dial, Complete with Knob, Extension Handle and Indicator Button	1.50
137F	Moulded Knob (same as used on 101 Condenser)	0.90
4″	Dial (same as used on 101 Condenser)	0.75
137F	Knob and 4″ Dial Mounted	1.85
101EX	8″ Extension Handle for 137 F Knob	1.50
139LN	Large Indicator Button (same as used on 101 Condenser)	0.15
4″	Dial, Complete with Knob, Extension Handle and Indicator Button	3.50

The products of the General Radio Company cover a complete line of radio and electrical laboratory apparatus. Information and bulletins of special apparatus will be sent on request. Our line includes the following: Variable Air Condensers, Vernier Condenser, Standard Condensers, Decade Condensers, Variometers, Standards of Inductance, Standards of Resistance, Decade Resistance Boxes, Wavemeters, Decade Bridge, Capacity Bridge, Slide Wire Bridge, Audibility Meters, Hot Wire Meters, Galvanometers, Thermo-Couples, Telephone Transformer, Miscellaneous Apparatus.

All prices in this bulletin are strictly net, subject to change without notice, F. O. B. Cambridge, Mass. Cash should accompany orders from persons or firms with whom we have not already opened accounts. Unless otherwise instructed we shall use our own judgment regarding method of shipment.

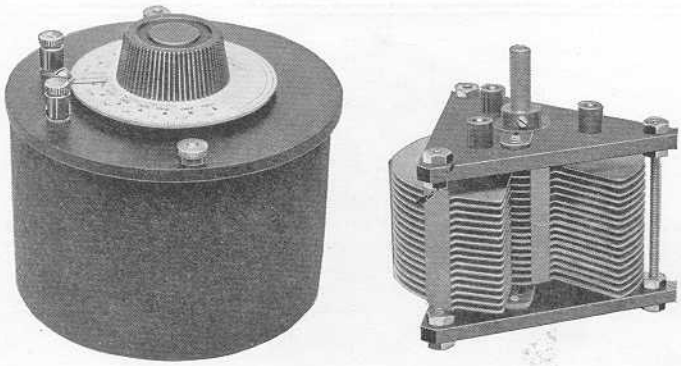
This Bulletin replaces Bulletins 304, 906, 908, and 909.

Standardize on General Radio Apparatus Throughout.

The instruments listed in this Bulletin may be obtained directly from our factory at Cambridge, Massachusetts, or may be purchased through your local dealer.

Type 247
VARIABLE AIR CONDENSER

Experimental radio receiving sets require condensers whose quality is high and whose price is reasonable. It is easy to manufacture low-priced condensers as is evidenced by the large number now available. It is more difficult, however, to construct a condenser which is electrically and mechanically good, and yet at the same time to keep the cost of construction low.



For many years the subject of dielectric losses and condenser design has been studied in the Research Laboratory of the General Radio Company. This study has been carried on primarily in order to obtain data for the design of special condensers built to the exacting standards of scientific research work. With this information available, and with our experience in the design of laboratory instruments, we have been able to design a condenser of unusual merit for radio work and, at the same time, to keep its cost of construction remarkably low.

The value of a good condenser in a receiving set is not always fully appreciated. The dielectric losses of the condenser are equivalent to adding a series resistance in the oscillating circuit. To add a series resistance in the oscillating circuit means loss of energy which, in turn, means broad tuning and diminished signal strength. It is thus important that the dielectric losses in condensers be kept low. In this condenser these losses are kept low by using only a high-grade hard rubber for the solid dielectric. They are further kept low by using only a small quantity of this dielectric and so placing it with respect to the electrostatic field that the dielectric hysteresis losses are kept a minimum.

This is just one of the points which have received careful attention in the design of this condenser. Other important features include the following:

CAPACITY SCALE: In addition to the regular degree graduations of the etched metal dial, this dial has marked on it a scale showing capacities in micromicrofarads. This is a unique and valuable feature for radio receiving condensers, and it enables the operator to know at all times just what capacity he is using.

PLATES SOLDERED TOGETHER: In order that the plate resistance may be kept constant and that the capacity always will remain the same the plates of each unit of the condenser are soldered together.

HEAVY BRASS PLATES: The plates are of heavy sheet brass adequately spaced to prevent short-circuiting. Rugged plates of good conductivity are very desirable features in condenser construction.

BEARINGS: A special type spring bearing is used to insure good contact being made with the rotary plates. With this special type of bearing the tension always remains the same, and there is no chance for the rotary plate unit to loosen as the bearing wears. These bearings are so arranged that all the thrust is on one bearing, so that there is no danger of the condenser short-circuiting or changing its capacity if the distance between the bearings becomes changed.

LOW ZERO CAPACITY: The zero capacity of this condenser is approximately 20 micromicrofarads. This low value makes a wide range of wavelengths possible. The maximum capacity is 1000 micromicrofarads.

METAL CASE GROUNDED TO ROTARY PLATES: The condenser is mounted in a metal case finished with our black crystalline finish, the same as is used on our most expensive laboratory instruments. This case is grounded to the rotary plates, thus shielding the condenser and eliminating many of the disturbing effects due to bringing the hand near the condenser.

Do not deny your receiving set the advantages of a scientifically designed condenser.

Type 247A Condenser, completely mounted $5.50

Dimensions 4½"D x 3½". Weight 1¾ lb.

Code Word "CRONY."

This condenser may also be supplied without case, panel, knob, dial or binding posts, but with counterweight, suitable for back of panel mounting.

Type 247B Condenser, unmounted $3.25

Dimensions 3¾" x 3¾" x 3½". Weight 1 lb.

Code Word "CRUEL."

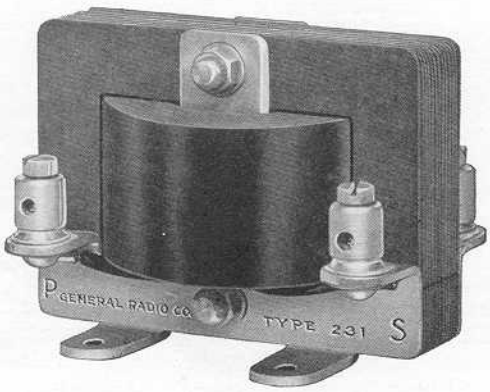
Knob and dial, without capacity graduations, for use with Type 247B Condenser ..... $ .50

Unless otherwise specified the dial supplied with the Type 247B Condenser will not have the capacity scale added. The capacity scale will be added, without charge, whenever specified.

Type 231A
AMPLIFYING TRANSFORMER

The remarkable results obtained in long distance radio communication in recent years have been due largely to amplification made possible by the use of vacuum tubes. The experimenter has been at a decided disadvantage, due to his inability to get suitable vacuum tubes. Fortunately, this question has now been settled and satisfactory tubes are available.

In order to get the maximum of results from these tubes as amplifiers, they must be used with correctly designed amplifying transformers. Our Type 231A transformer was built specifically to meet this situation. The primary receives the maximum amount of energy and delivers it undistorted in waveform and at the correct potential to the grid of the amplifying tube.



The core construction is such that there is little tendency for the setting up of external fields, with the resultant howling in the audio frequency circuit. The distributed capacity of the secondary is low, so that the maximum potential is obtained on the grid of the tube.

The primary has a direct current resistance of 1,100 ohms, an alternating current resistance at 1,000 cycles of 11,000 ohms, and a reactance at this frequency of 66,000 ohms. These figures for the secondary are 5,500, 130,000 and 700,000 ohms respectively.

In order to obtain the best results from an amplifying transformer, certain precautions should be observed. Since what is wanted is the production of the maximum potential, or rather change of potential on the grid of the amplifying tube, it is best to connect the grid to the outside terminal of the secondary of the transformer. This is because the outer portion of the secondary has smaller capacity to ground than the inner portion, due to the proximity of the latter to the primary winding, which is connected to the filament and other low potential parts of the circuit. This capacity effect increases with frequency and therefore reduces the intensity of high notes proportionately more than

low ones, thus tending to cause distortion. Howling, or oscillation at audio frequencies, is caused by coupling (either electrostatic or magnetic) of the amplifier grid to some other part of the circuit, and is more troublesome with two or more stages of amplification than with one. If the electrostatic and magnetic couplings are made to oppose each other, the tendency to oscillate is minimized, and when a transformer is connected into a circuit it is worth while to reverse the leads to the primary to see which connection is better. In some cases, the oscillations are above audibility, but the strength of signals is reduced, nevertheless.

In an oscillating detector circuit the capacity of the telephone cords (which is of the order of 75 M.M.F.) is often sufficient to by-pass the radio frequency current around the high inductance of the phones, but when the primary of an amplifying transformer is substituted for the phones, it should be shunted with a condenser of a few hundred micro-microfarads or more.

Aside from its excellent electrical characteristics, this transformer is well designed mechanically. It is compact, and by means of the four projecting feet, each with a screw hole, may be mounted in any position. The core and coil are finished in black, while the brackets and binding posts are nickeled. Particular attention is called to the accessibility of both the binding posts and the mounting brackets.

Type 231A Amplifying Transformer $5.00

Dimensions 2⅝" x 2½" x 2½". Weight 1 lb.

Code Word : "TUTOR."

Type 231M
MODULATION TRANSFORMER

This transformer is similar in general design to the Type 231A amplifying transformer, the only difference being in the winding. Its windings have been designed particularly for use with the Radiotron UV-202 five-watt transmitting tubes and other tubes of similar characteristics. To get the maximum modulation, the modulating device should have an impedance somewhat greater than the input impedance of the tube. This impedance is of the order of several hundreds thousand ohms, while that of a telephone transmitter is but a few ohms. A modulation transformer serves to adapt the telephone transmitter impedance to that of the input circuit of the tube. The success of a radio telephone installation depends not only on the value of the antenna current, but also on how completely that current is modulated. Our Type 231M transformer has been designed to give the maximum modulation which is possible without distortion.

Type 231M Modulation Transformer $5.00

Dimensions 2⅝" x 2½" x 2½". Weight, 1 lb.

Code Words: "TUNIC."

TYPE 127
HOT WIRE AMMETERS

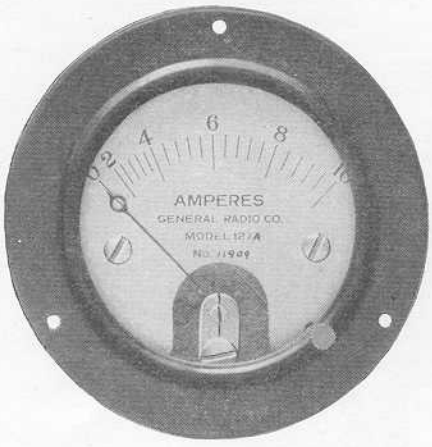
In spark transmitting stations a radiation ammeter is a great convenience; in continuous wave stations it is almost a necessity. It is also desirable to know the filament current of vacuum tubes. This is particularly true of transmitting tubes. The charging rate of storage batteries should be known. These requirements of experimental radio stations make it necessary to possess an ammeter equally accurate on direct currents and on currents of radio frequency. Such a meter should have low impedance. It should be rugged and reliable. The Type 127 Hot Wire Ammeters were built to meet these requirements. During the recent war the U. S. Army and Navy used large numbers of these meters.

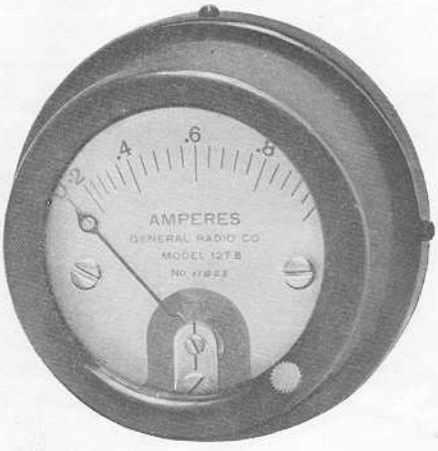
The expanding strip in these meters is of thin platinum, so as to prevent oxidation. It is so proportioned that it works at a low temperature and is of low resistance. These are two highly desirable features, since the former permits reasonable overloading without burning out, and the latter minimizes the losses.

The type of multiplying action is such that a more uniform scale is obtained than with many hot wire meters. These meters have been corrected for temperature so that there is very little shift of zero. Any necessary correction may be made by adjusting a knurled screw.

These instruments are made in three types, the flush mounting for use on panels, the front-of-board mounting for use on switchboards, and the portable type for general use. In mounting the flush type of meter an opening in the panel 2⅝ inches in diameter should be provided.

In mounting the front-of-board type allowance should be made for a case 3 inches in diameter. The flush type meters are mounted in metal cases finished in black japan, while the front-of-board and portable types have cases of moulded bakelite.





TYPE 127A

Range		Code Word	Case	Price
100	Milli-Amps.	MEDAL	Flush Mounting	$9.00
¼	Amp.	MERCY	Flush Mounting	7.75
½	Amp.	MERIT	Flush Mounting	7.75
1	Amp.	MERRY	Flush Mounting	7.75
2.5	Amps.	MINOR	Flush Mounting	7.75
5	Amps.	MINIM	Flush Mounting	7.75
10	Amps.	MINNY	Flush Mounting	7.75
	Galvanometer	MITER	Flush Mounting	7.25

Dimensions 3 in. x 1½ in. Weight 9½ oz.

TYPE 127B

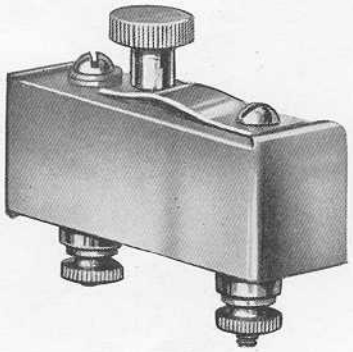
100	Milli-Amps.	MAYOR	Front of Board	9.00
¼	Amp.	MADAM	Front of Board	7.75
½	Amp.	MAJOR	Front of Board	7.75
1	Amp.	MANOR	Front of Board	7.75
2.5	Amps.	MAPLE	Front of Board	7.75
5	Amps.	MATIN	Front of Board	7.75
10	Amps.	MAXIM	Front of Board	7.75
	Galvanometer	MAGIC	Front of Board	7.25

Dimensions 3 in. d. x 1½ in. Weight 9 oz.

TYPE 127C

100	Milli-Amps.	MUGGY	Portable	10.00
¼	Amp.	MOCHA	Portable	9.00
½	Amp.	MOGUL	Portable	9.00
1	Amp.	MOLAR	Portable	9.00
2.5	Amps.	MOTOR	Portable	9.00
5	Amps.	MUMMY	Portable	9.00
10	Amps.	MUSTY	Portable	9.00
	Galvanometer	MOTTO	Portable	8.50

Dimensions 3 in. x 4 in. x 1½ in. Weight 10½ oz.



TYPE 178
HIGH FREQUENCY BUZZER

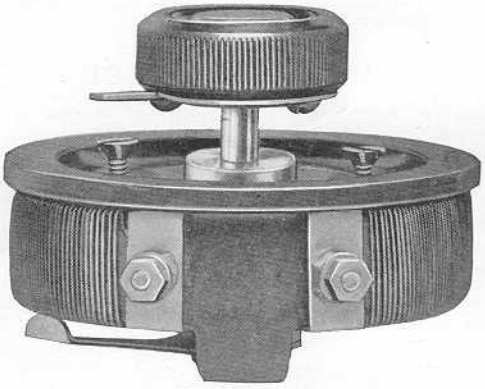
This buzzer has been designed for both laboratory and radio use. It combines pureness of tone, simplicity of adjustment and durability.

The frequency is approximately 800 cycles, but depends on the setting of the knurled adjusting screw. As the current required for the operation of the buzzer is approximately only 30 milli-amperes, it may be operated for long periods of time from small batteries. One dry cell will provide sufficient potential to operate this buzzer satisfactorily.

One of the noteworthy features of this buzzer is its freedom from sparking. This is important where pure tones are required. This feature makes the buzzer particularly adapted as a supply source for bridge measurements and for continuous wave telegraph modulation.

Dimensions 2" x 1¾" x 1". Weight 3 oz.

Type	Mounting	Code Word	Price
178A	Above Panel	BEFOG	$2.00
178B	Below Panel	BEGET	$2.00



TYPE 214
RHEOSTAT

The Type 214 Rheostat is a convenient, practical instrument for experimental service or for permanent installations. It is made in two types, 214A for back of panel mounting, and 214B for front of panel mounting and portable use. The illustration shows the back of panel type. In this type when mounted, only the knob and pointer project through the panel. The shaft may be adjusted for any thickness of panel up to ⅜". Ruggedness of construction and smoothness of operation make this rheostat especially adapted for laboratory and radio use. There is no grating or clicking of the contact arm.

This rheostat is made for three general classes of service. The first type is for the regulation of receiving tube filament currents. This rheostat has a resistance of 7 ohms and a current carrying capacity of 1.5 amperes. The second type is for the regulation of filament currents of 5 watt transmitting tubes. This rheostat has a resistance of 2 ohms and a carrying capacity of 2.5 amperes. It is sufficient for the regulation of a Radiotron UV202 tube on as high as a 12 volt supply source.

The third type of rheostat is the high resistance type. It is carried in stock in resistances of 80 and 400 ohms with current carrying capacities of 0.3 and 0.1 amperes respectively. When equipped with a third binding post with connection to the switch blade, this rheostat makes a very excellent potentiometer for biasing grids of detector tubes and for other purposes.

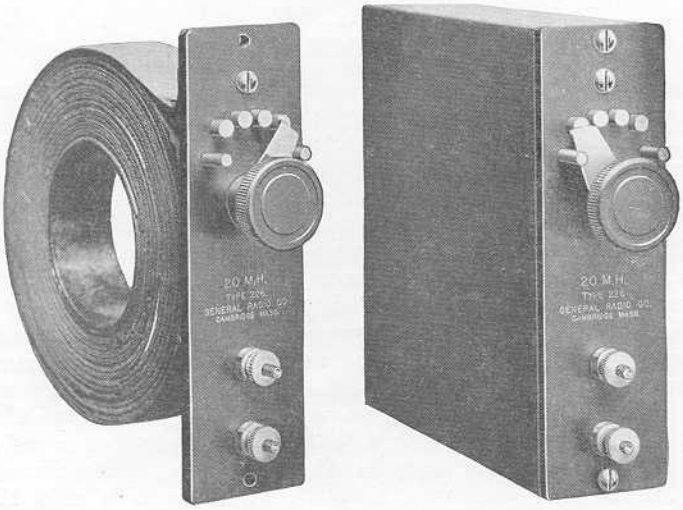
Dimensions 3" d. x 2¼". Weight 7 oz.

		Code Word		
Resistance	Current	Type 214A	Type 214B	Price
2 ohms	2.5 amp.	RUDDY	RUMOR	$2.50
7 ohms	1.5 amp.	RURAL	RUSTY	$2.50
80 ohms	0.3 amp.	REVEL	RIFLE	$3.50
400 ohms	0.1 amp.	RIGID	RIVAL	$3.50
80 ohms	Potentiometer	RIVET	ROMAN	$4.00
400 ohms	Potentiometer	ROSIN	ROWEL	$4.00

Special resistances up to 400 ohms may also be supplied, but the total energy absorbed should not exceed 16 watts.

Type 226
FOUR STEP INDUCTOR

The tuned circuits of an experimental radio receiving station must be capable of operating over a wide range. They should extend from 150 meters to above 20,000 meters. It is impractical to construct a single coil, even when equipped with a slider and sectionalizing switches to cover this entire range. It has become common practice to employ several sets of coils to cover this range. If coils without taps are used, the number required is so large that it is inconvenient to make the many changes required when working at a variety of wavelengths.



We have designed a set of four coils, each with four taps, which are particularly adapted for use in radio receiving sets. Although built with four different values of inductance they have the same physical dimensions thus permitting two or more circuits to be coupled together. By working at the extreme limits of each coil it would be possible to cover the range referred to above with three sizes instead of four. The four sizes, however, give a much greater flexibility than do three.

The coils are approximately of Maxwellian shape. The winding is such as to keep the distributed capacitance a minimum. This is a particularly important feature in that it increases the range over which any one coil may be used, and what is more important, it increases the efficiency of the coil by keeping the dielectric losses a minimum. These coils, are rugged in construction and attractive in appearance. The case is of polished oak with engraved bakelite panel. The metal parts are finished in polished nickel.

One very distinctive feature about these coils is that they are self-supporting and, accordingly, do not require any auxiliary mounting. Coupling between coils is varied by simply changing the distance between coils or by turning through any desired angle. The arrangement of taps is such as to give values of approximately 20%, 45%, 75%and 100% of the maximum inductance.

These coils are adapted for general laboratory use as well as for radio receiving sets. It is seldom necessary to use a complete set of twelve coils to cover all ranges from 150 to above 20,000 meters. A satisfactory arrangement for this range is the following selection:

3 A Coils, 3 C Coils and 3 D Coils.

The ranges covered by these coils when used with one of our type 247 Condensers, which has a maximum capacitance of 1000 micromicrofards, are shown in the following table:

Type	Max. Ind.	Resistance	Approximate Range	Code Word	Price
226A	0.3 M.H.	0.8 Ohm	140- 1000 meters	IMAGE	$6.00
226B	3.0 M.H.	0.9 Ohm	400- 3000 meters	IMBED	$6.00
226C	20.0 M.H.	2.5 Ohms	1100- 8000 meters	IMBUE	$6.00
226D	125.0 M.H.	30.0 Ohms	3000-24000 meters	IMPEL	$6.00

Dimensions 5" x 6" x 1½". Weight 2½ lbs.

VACUUM TUBES

The Radio Corporation of America is now selling for experimental use several types of vacuum tubes developed by the General Electric Co. We can supply the following tubes.

Radiotron UV200 ..... $5.00
Radiotron UV201 ..... $6.50
Radiotron UV202 ..... $8.00

The UV200 is a gas content detector and amplifier tube and should have an accurate adjustment of the plate voltage, which is approximately 20. The UV201 is a more stable tube than the UV200 and does not require an accurate adjustment of the plate voltage. It will operate on one or two 22½ volt plate batteries and when used as an amplifier up to five batteries may be used with increasing amplification. The UV202 tubes are five watt oscillators requiring plate voltages of 350.

The UV200 and 201 tubes require filament voltages of 5 and currents of 1 ampere. The filament voltage of the UV202 tube is 7.5 and the current 2.35 amperes.

WESTERN ELECTRIC HEAD PHONES

This receiver, formerly known as the "P11," was adopted as standard by both the Army and Navy during the war. Combining as it does, sensitivity with great ruggedness, it is unusually well adapted to use in the laboratory and in the receiving station.

Price, complete with cord $15.00

Types 206 and 215
VACUUM TUBE AMPLIFIERS

One of the earliest uses of vacuum tubes was in the amplification of detected radio signals. This type of amplification, commonly termed —audio frequency amplification—still remains the simplest and most popular form.

Type 206
ONE STEP AMPLIFIER

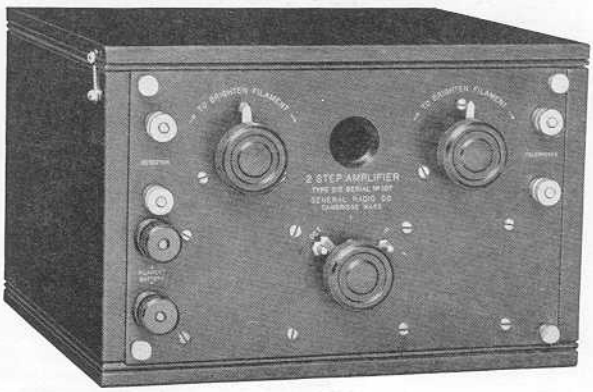
For those who desire complete amplifier units, we have developed our Type 206 one-stage and Type 215 two-stage amplifier cabinets. These cabinets are complete except for storage batteries. There is a compartment provided for the high-voltage plate battery. This compartment will hold one 22-volt standard Navy type battery or five 22-volt small Signal Corps type batteries. The energy amplification of each stage is 400.

Attention is called to the great flexibility of the two-stage unit. By means of a single drum switch constructed to have high insulation resistance and a very low electrostatic capacitance, the connections may be shifted so that the amplifier is entirely cut out, one stage only used, or both stages connected. This switch provides positive control including the tube filament circuits; thus, when the switch is set on "detector," no amplifier tubes are burning and when set for one stage, only one amplifier tube is burning. Complete control from the detector to two stages of amplification is thus provided without the necessity of changing a single connection.

All of the parts used in these amplifier units are our standard high quality parts. These parts are illustrated and described on the other pages of this bulletin.

The panels of both the one and two-stage units are removable so that the wiring and separate instruments may be readily examined.

The covers of the cabinets are hinged and on each is mounted a wiring diagram showing the complete connections of the set. The filament rheostat is adapted for either a four or six-volt battery.



Type 215
TWO STEP AMPLIFIER

The cabinets are of polished oak fitted with engraved bakelite panels. The metal parts are of brass, finished in polished nickel.

Type 206 1 Step Amplifier $28.00
Dimensions 8" x 7" x 9. Weight 6¼ lbs.
Code Word: "AMPLE."

Type 215 2 Step Amplifier $50.00
Dimensions 10" x 7" x 9". Weight 9½ lbs.
Code Word: "ANNEX."

The above prices do not include either vacuum tubes or batteries.

Navy type Everready Batteries, 22 volts $3.00
Radiotron UV201 Vacuum Tubes 6.50

TYPE 174
DIRECT READING WAVEMETER

The Type 174 Wavemeter is designed for general use in commercial and experimental stations. Its equipment is such that it is adapted for use with receiving and transmitting apparatus employing either damped or undamped waves. It is self-contained and direct reading, features which make the instrument particularly valuable for commercial work.

A hot wire galvanometer is used for indicating resonance of transmitted signals, while for received signals a crystal detector and binding posts for telephones are provided. For producing damped oscillations of known wavelengths, the wavemeter is equipped with a high frequency buzzer.

The oscillating circuit consists of three coils with a selector switch and a variable air condenser. This combination gives a wavelength range of 130-3000 meters.

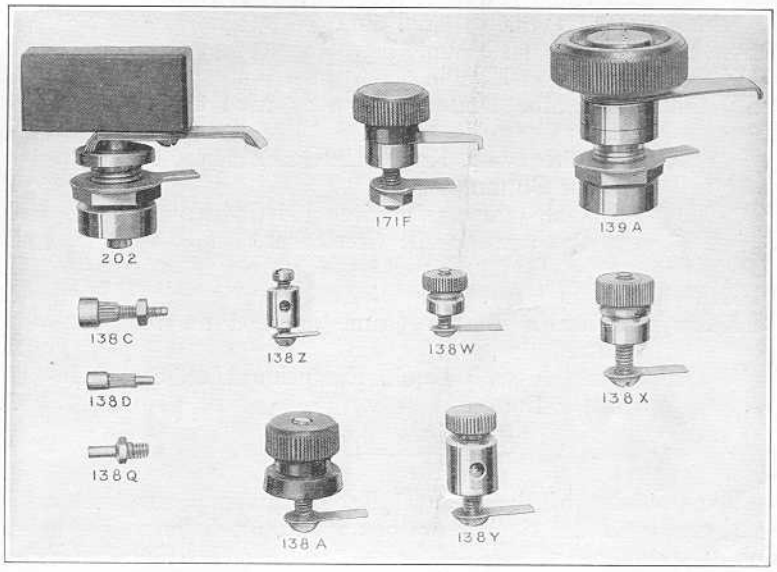
Particular care has been given to the mechanical construction and to the appearance of this instrument. All of the equipment is mounted on a bakelite panel and enclosed in a polished walnut carrying case. The metal parts are finished in polished nickel.

Type 174 Direct Reading Wavemeter $68.00

Code Word: "WITTY."

Dimensions 9" x 7" x 6". Weight 6¾ lbs.

STANDARD PARTS



Experimental work frequently requires that the experimenter build special pieces of apparatus in his own laboratory. When this apparatus is of a permanent or semi-permanent nature, it is desirable to have the binding posts, switches and other parts of the best quality, and to have them match instruments already installed. Consequently, we are now listing many of the standard parts used in the assembly of our own instruments.

BINDING POSTS

Type	Description	Screw Size	Price
138A	Insulated	10-32	$0.40
138W	Nickel Plated Brass	6-32	0.15
138X	" " "	10-32	0.18
138Y	" " "	10-32	0.18
138Z	" " "	6-32	0.10

SWITCHES AND PARTS

Type	Description	Price
139A	Multiple Leaf Switch 1⅜" radius	$0.95
171F	Single Leaf Switch ⅞" radius	0.40
202	Low Contact Resistance Switch 1⅜" radius	1.25
138C	5/16" Contact for 139A or 202 Switches	0.05
138D	3/16" Contact for 171F Switch	0.04
138Q	Switch Stop	0.05

DIALS AND KNOBS

137D	Moulded Knob (same as used on 239 Condenser)	0.40
3″	Metal Dial (same as used on 239 Condenser)	0.50
137D	Knob and 3″ Dial Mounted	1.00
137EX	Small Extension Handle	0.35
139SN	Small Indicator Button (same as used on 239 Condenser)	0.15
3″	Dial, Complete with Knob, Extension Handle and Indicator Button	1.50
137F	Moulded Knob (same as used on 101 Condenser)	0.90
4″	Dial (same as used on 101 Condenser)	0.75
137F	Knob and 4″ Dial Mounted	1.85
101EX	8″ Extension Handle for 137 F Knob	1.50
139LN	Large Indicator Button (same as used on 101 Condenser)	0.15
4″	Dial, Complete with Knob, Extension Handle and Indicator Button	3.50

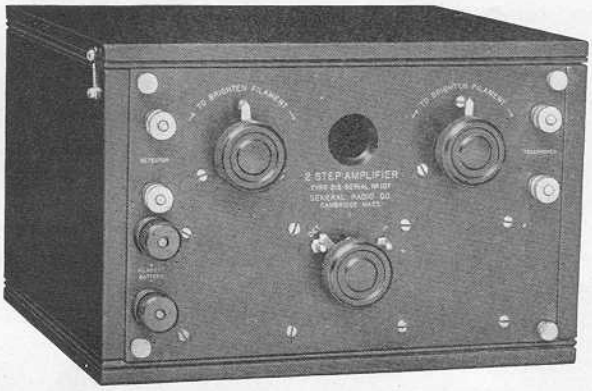
The products of the General Radio Company cover a complete line of radio and electrical laboratory apparatus. Information and bulletins of special apparatus will be sent on request. Our line includes the following: Variable Air Condensers, Vernier Condenser, Standard Condensers, Decade Condensers, Variometers, Standards of Inductance, Standards of Resistance, Decade Resistance Boxes, Wavemeters, Decade Bridge, Capacity Bridge, Slide Wire Bridge, Audibility Meters, Hot Wire Meters, Galvanometers, Thermo-Couples, Telephone Transformer, Miscellaneous Apparatus.

All prices in this bulletin are strictly net, subject to change without notice, F. O. B. Cambridge, Mass. Cash should accompany orders from persons or firms with whom we have not already opened accounts. Unless otherwise instructed we shall use our own judgment regarding method of shipment.

This Bulletin replaces Bulletins 103, 304, 906, 908, 909, and 910

Standardize on General Radio Apparatus Throughout.

5/24/87



Type 215

TWO-STEP AMPLIFIER

The Type 215 Two-step Audio Frequency Amplifier represents the conventional unit. It has the added feature, however, of a single control switch for both the filament and plate circuits. By means of this switch, so constructed as to have high insulation resistance and low electrostatic capacitance, the connections may be shifted so that the amplifier is entirely cut out, one stage only used, or both stages connected. This switch provides positive control including the tube filament circuits; thus, when the switch is set on detector, no tubes are burning and when set for one stage, only one amplifier tube is burning. Complete control from the detector to two stages of amplification is thus provided without the necessity of changing a single connection.

All of the parts used in this amplifier are our standard high quality parts and are described on the other pages of this bulletin. The panel is removable so that the wiring and separate units may be readily examined. The cover of the cabinet is hinged and has mounted on the inside a wiring diagram of the unit. The filament rheostat is adapted for either a four or six volt battery.

The cabinet is of polished oak fitted with projecting engraved bakelite panel. The metal parts are of brass, finished in polished nickel. The unit is complete except for storage battery. A compartment, holding one 22-volt standard Navy type battery or five 22-volt small Signal Corps type batteries, is provided for the plate battery.

Type 215 2 Step Amplifier $50.00

Dimensions 10″ x 7″ x 9″. Weight 9½ lbs.

Code Word: "ANNEX."

The above price does not include either vacuum tubes or batteries.

Navy type Eveready Batteries, 22 volts $3.00

Radiotron UV-201 Vacuum Tubes 6.50

Type 127

HOT WIRE AMMETERS

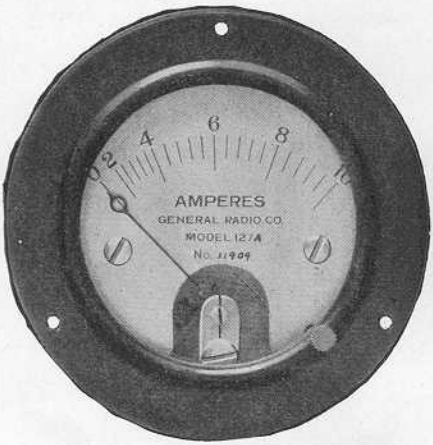
In spark transmitting stations a radiation ammeter is a great convenience; in continuous wave stations it is almost a necessity. It is also desirable to know the filament current of vacuum tubes. This is particularly true of transmitting tubes. The charging rate of storage batteries should be known. These requirements of experimental radio stations make it necessary to possess an ammeter equally accurate on direct currents and on currents of radio frequency. Such a meter should have low impedance. It should be rugged and reliable. The Type 127 Hot Wire Ammeters were built to meet these requirements. During the recent war the U. S. Army and Navy used large numbers of these meters.

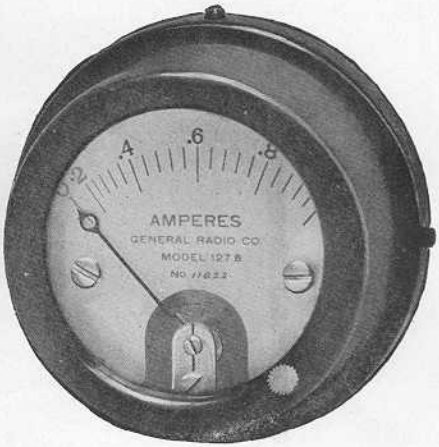
The expanding strip in these meters is of thin platinum, so as to prevent oxidation. It is so proportioned that it works at a low temperature and is of low resistance. These are two highly desirable features, since the former permits reasonable overloading without burning out, and the latter minimizes the losses.

The type of multiplying action is such that a more uniform scale is obtained than with many hot wire meters. These meters have been corrected for temperature so that there is very little shift of zero. Any necessary correction may be made by adjusting a knurled screw.

These instruments are made in three types, the flush mounting for use on panels, the front-of-board mounting for use on switchboards, and the portable type for general use. In mounting the flush type of meter an opening in the panel 2⅝ inches in diameter should be provided.

In mounting the front-of-board type allowance should be made for a case 3 inches in diameter. The flush type meters are mounted in metal cases finished in black japan, while the front-of-board and portable types have cases of moulded bakelite.





Type 127A

Range		Code Word	Case	Price
100	Milli-Amps.	MEDAL	Flush Mounting	$9.00
¼	Amp.	MERCY	Flush Mounting	7.75
½	Amp.	MERIT	Flush Mounting	7.75
1	Amp.	MERRY	Flush Mounting	7.75
2.5	Amps.	MINOR	Flush Mounting	7.75
5	Amps.	MINIM	Flush Mounting	7.75
10	Amps.	MINNY	Flush Mounting	7.75
	Galvanometer	MITER	Flush Mounting	7.25

Dimensions 3″ d. x 1½″. Weight 9½ oz.

Type 127B

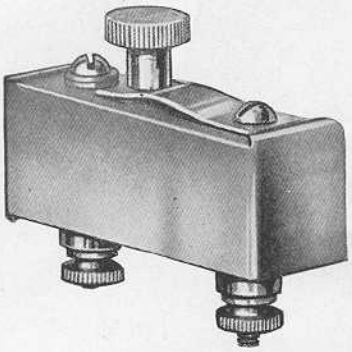
100	Milli-Amps.	MAYOR	Front of Board	$9.00
¼	Amp.	MADAM	Front of Board	7.75
½	Amp.	MAJOR	Front of Board	7.75
1	Amp.	MANOR	Front of Board	7.75
2.5	Amps.	MAPLE	Front of Board	7.75
5	Amps.	MATIN	Front of Board	7.75
10	Amps.	MAXIM	Front of Board	7.75
	Galvanometer	MAGIC	Front of Board	7.25

Dimensions 3″ d. x 1½″. Weight 9 oz.

Type 127C

Range	Code Word	Case	Price
100 Milli-Amps.	MUGGY	Portable	$10.00
¼ Amp.	MOCHA	Portable	9.00
½ Amp.	MOGUL	Portable	9.00
1 Amp.	MOLAR	Portable	9.00
2.5 Amps.	MOTOR	Portable	9.00
5 Amps.	MUMMY	Portable	9.00
10 Amps.	MUSTY	Portable	9.00
Galvanometer	MOTTO	Portable	8.50

Dimensions 3″ x 4″ x 1½″. Weight 10½ oz.



Type 178
HIGH FREQUENCY BUZZER

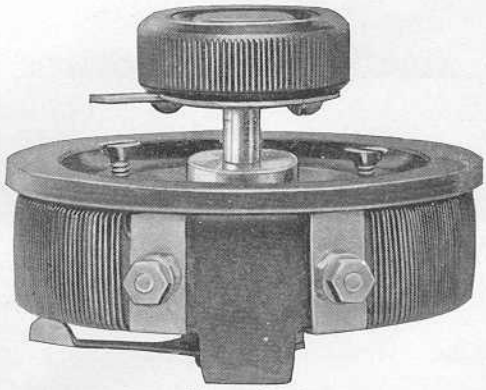
This buzzer has been designed for both laboratory and radio use. It combines pureness of tone, simplicity of adjustment and durability.

The frequency is approximately 800 cycles, but depends on the setting of the knurled adjusting screw. As the current required for the operation of the buzzer is approximately only 30 milli-amperes, it may be operated for long periods of time from small batteries. One dry cell will provide sufficient potential to operate this buzzer satisfactorily.

One of the noteworthy features of this buzzer is its freedom from sparking. This is important where pure tones are required. This feature makes the buzzer particularly adapted as a supply source for bridge measurements and for continuous wave telegraph modulation.

Dimensions 2″ x 1¾″ x 1″. Weight 3 oz.

Type	Mounting	Code Word	Price
178A	Above Panel	BEFOG	$2.00
178B	Below Panel	BEGET	2.00



Type 214
RHEOSTAT

The Type 214 Rheostat is a convenient, practical instrument for experimental service or for permanent installations. It is made in two types, 214A for back of panel mounting, and 214B for front of panel mounting and portable use. The illustration shows the back of panel type. In this type when mounted, only the knob and pointer project through the panel. The shaft may be adjusted for any thickness of panel up to ⅜". Ruggedness of construction and smoothness of operation make this rheostat especially adapted for laboratory and radio use. There is no grating or clicking of the contact arm.

This rheostat is made for three general classes of service. The first type is for the regulation of receiving tube filament currents. This rheostat has a resistance of 7 ohms and a current carrying capacity of 1.5 amperes. The second type is for the regulation of filament currents of 5 watt transmitting tubes. This rheostat has a resistance of 2 ohms and a carrying capacity of 2.5 amperes. It is sufficient for the regulation of a Radiotron UV202 tube on as high as a 12 volt supply source.

The third type of rheostat is the high resistance type. It is carried in stock in resistances of 80 and 400 ohms with current carrying capacities of 0.3 and 0.1 amperes respectively. When equipped with a third binding post with connection to the switch blade, this rheostat makes a very excellent potentiometer for biasing grids of detector tubes and for other purposes.

Dimensions 3" d. x 2¼". Weight 7 oz.

		Code Word		
Resistance	Current	Type 214A	Type 214B	Price
2 ohms	2.5 amp.	RUDDY	RUMOR	$2.25
7 ohms	1.5 amp.	RURAL	RUSTY	2.25
80 ohms	0.3 amp.	REVEL	RIFLE	2.75
400 ohms	0.1 amp.	RIGID	RIVAL	2.75
80 ohms	Potentiometer	RIVET	ROMAN	3.00
400 ohms	Potentiometer	ROSIN	ROWEL	3.00

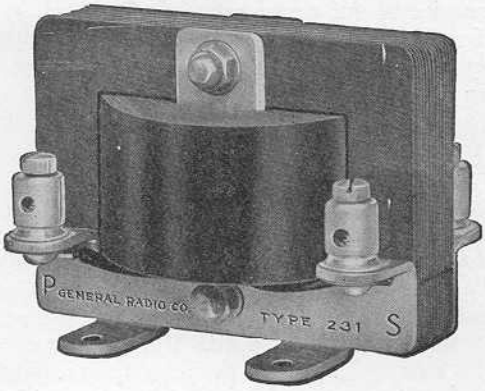
Special resistances up to 400 ohms may also be supplied, but the total energy absorbed should not exceed 16 watts.

Type 231A

AMPLIFYING TRANSFORMER

The remarkable results obtained in long distance radio communication in recent years have been due largely to amplification made possible by the use of vacuum tubes. The simplest and most common type of amplification is that of the detected signals, and is commonly called audio frequency amplification.

In order to get the maximum of results with this type of amplification, the impedance of the grid circuit of the amplifier tube must be adjusted to the impedance of the previous detector or amplifier tube output circuit. This can best be accomplished by means of a suitably designed transformer. Our Type 231A transformer was built specifically to meet this situation. The primary receives the maximum amount of energy and delivers it undistorted in waveform and at the correct potential to the grid of the amplifying tube.



The core construction is such that there is little tendency for the setting up of external fields, with the resultant howling in the audio frequency circuit. The distributed capacity of the secondary is low, so that the maximum potential is obtained on the grid of the tube.

The primary has a direct current resistance of 1,100 ohms, an alternating current resistance at 1,000 cycles of 11,000 ohms, and a reactance at this frequency of 66,000 ohms. These figures for the secondary are 5,500, 130,000 and 700,000 ohms respectively.

In order to obtain the best results from an amplifying transformer, certain precautions should be observed. Since what is wanted is the production of the maximum potential, or rather change of potential on the grid of the amplifying tube, it is best to connect the grid to the outside terminal of the secondary of the transformer. This is because the outer portion of the secondary has smaller capacity to ground than the inner portion, due to the proximity of the latter to the primary winding, which is connected to the filament and other low potential parts of the circuit. This capacity effect increases with frequency and therefore reduces the intensity of high notes proportionately more than

low ones, thus tending to cause distortion. Howling, or oscillation at audio frequencies, is caused by coupling (either electrostatic or magnetic) of the amplifier grid to some other part of the circuit, and is more troublesome with two or more stages of amplification than with one. If the electrostatic and magnetic couplings are made to oppose each other, the tendency to oscillate is minimized, and when a transformer is connected into a circuit it is worth while to reverse the leads to the primary to see which connection is better. In some cases, the oscillations are above audibility, but the strength of signals is reduced, nevertheless.

In an oscillating detector circuit the capacity of the telephone cords (which is of the order of 75 MMF) is often sufficient to by-pass the radio frequency current around the high inductance of the phones, but when the primary of an amplifying transformer is substituted for the phones, it should be shunted with a condenser of a few hundred micro-microfarads or more.

Aside from its excellent electrical characteristics, this transformer is well designed mechanically. It is compact, and by means of the four projecting feet, each with a screw hole, may be mounted in any position. The core and coil are finished in black, while the brackets and binding posts are nickeled. Particular attention is called to the accessibility of both the binding posts and the mounting brackets.

Every transformer is guaranteed.

Type 231A Amplifying Transformer $5.00
Dimensions 2⅝" x 2½" x 2½". Weight 1 lb.
Code Word: "TUTOR."

Type 231M

MODULATION TRANSFORMER

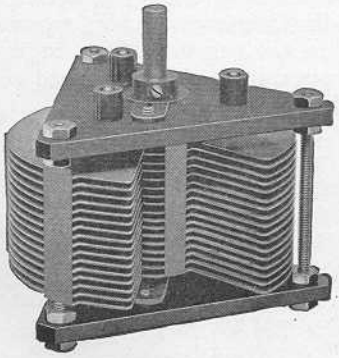
This transformer is similar in general design to the Type 231A amplifying transformer, the only difference being in the winding. Its windings have been designed particularly for use with the Radiotron UV-202 five-watt transmitting tubes and other tubes of similar characteristics. To get the maximum modulation, the modulating device should have an impedance somewhat greater than the input impedance of the tube. This impedance is of the order of several hundred thousand ohms, while that of a telephone transmitter is but a few ohms. A modulation transformer serves to adapt the telephone transmitter impedance to that of the input circuit of the tube. The success of a radio telephone installation depends not only on the value of the antenna current, but also on how completely that current is modulated. Our Type 231M transformer has been designed to give the maximum modulation which is possible without distortion.

Type 231M Modulation Transformer $5.00
Dimensions 2⅝" x 2½" x 2½". Weight 1 lb.
Code Word: "TUNIC."

Type 247

VARIABLE AIR CONDENSER

Experimental radio receiving sets require condensers whose quality is high and whose price is reasonable. It is easy to manufacture low-priced condensers as is evidenced by the large number now available. It is more difficult, however, to construct a condenser which is electrically and mechanically good, and yet at the same time to keep the cost of construction low.



For many years the subject of dielectric losses and condenser design has been studied in the Research Laboratory of the General Radio Company. This study has been carried on primarily in order to obtain data for the design of special condensers built to the exacting standards of scientific research work. With this information available, and with our experience in the design of laboratory instruments, we have been able to design a condenser of unusual merit for radio work and, at the same time, to keep its cost of construction remarkably low.

The value of a good condenser in a receiving set is not always fully appreciated. The dielectric losses of the condenser are equivalent to adding a series resistance in the oscillating circuit. To add a series resistance in the oscillating circuit means loss of energy which, in turn, means broad tuning and diminished signal strength. It is thus important that the dielectric losses in condensers be kept low. In this condenser these losses are kept low by using only a high-grade hard rubber for the solid dielectric. They are further kept low by using only a small quantity of this dielectric and so placing it with respect to the electrostatic field that the dielectric hysteresis losses are kept a minimum.

This is just one of the points which have received careful attention in the design of this condenser. Other important features include the following:

CAPACITY SCALE: In addition to the regular degree graduations of the etched metal dial, this dial has marked on it a scale showing capacities in micromicrofarads. This is a unique and valuable feature for radio receiving condensers, and it enables the operator to know at all times just what capacity he is using.

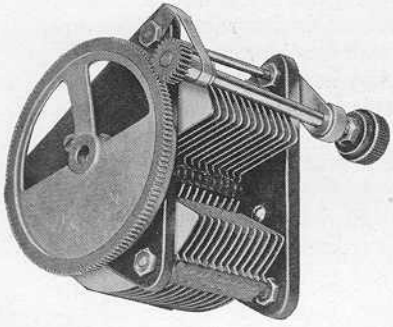
PLATES SOLDERED TOGETHER: In order that the plate resistance may be kept constant and that the capacity always will remain the same the plates of each unit of the condenser are soldered together.

HEAVY BRASS PLATES: The plates are of heavy sheet brass adequately spaced to prevent short-circuiting. Rugged plates of good conductivity are very desirable features in condenser construction.

BEARINGS: A special type spring bearing is used to insure good contact being made with the rotary plates. With this special type of bearing the tension always remains the same, and there is no chance for the rotary plate unit to loosen as the bearing wears. These bearings are so arranged that all the thrust is on one bearing, so that there is no danger of the condenser short-circuiting or changing its capacity if the distance between the bearings becomes changed.

LOW ZERO CAPACITY: The zero capacity of this condenser is approximately 20 micromicrofarads. This low value makes a wide range of wavelengths possible.

METAL CASE GROUNDED TO ROTARY PLATES: The condenser is mounted in a metal case finished with our black crystalline finish, the same as is used on our most expensive laboratory instruments. This case is grounded to the rotary plates, thus shielding the condenser and eliminating many of the disturbing effects due to bringing the hand near the condenser.



The fine adjustment required in tuning to continuous wave stations has made some form of fine capacity adjustment desirable. The common method of connecting a second or vernier condenser of low capacity in parallel with the main condenser has the objection that two adjustments are required for each setting. We have overcome this objection and provided a positive control throughout the entire range of the condenser by attaching a gear and pinion. By a single setting a finer adjustment is now possible than with the older two-adjustment vernier combination.

Do not deny your receiving set the advantages of a scientifically designed condenser.

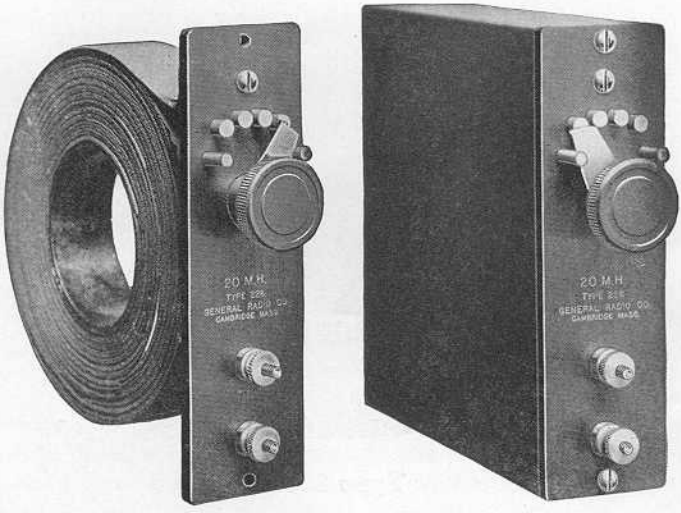
Type 247A 1000 MMF. Mounted. Without gear $6.00
Dimensions 5" x 5" x 4½". Weight 1¾ lbs.
Code Word: "CRONY."
Type 247B 1000 MMF. Unmounted. Without gear $3.75
Dimensions 4" x 4" x 4⅛". Weight 1 lb.
Code Word: "CRUEL."
Type 247C 1000 MMF. Mounted. With gear $7.75
Dimensions 5" x 5" x 4½". Weight 2 lbs.
Code Word: "CYCLE."
Type 247D 1000 MMF. Unmounted. With gear $5.50
Dimensions 4" x 4" x 4⅛". Weight 1⅛ lbs.
Code Word: "CUBIT."
Type 247E 500 MMF. Mounted. Without gear $5.50
Dimensions 5" x 5" x 4½". Weight 1¾ lbs.
Code Word: "COUPE."
Type 247F 500 MMF. Unmounted. Without gear $3.25
Dimensions 4" x 4" x 4⅛". Weight 1 lb.
Code Word: "COCOA."
Type 247G 500 MMF. Mounted. With gear $7.25
Dimensions 5" x 5" x 5⅛". Weight 2 lbs.
Code Word: "COLIC."
Type 247H 500 MMF. Unmounted. With gear $5.00
Dimensions 4" x 4" x 4⅛". Weight 1⅛ lbs.
Code Word: "COMIC."
Knob and dial, without capacity graduations, and indicator button for use with unmounted condenser .....$ .50
Gear, pinion, pinion shaft and mounting supports, per set $1.75

Type 226
FOUR STEP INDUCTOR

The tuned circuits of an experimental radio receiving station must be capable of operating over a wide range. They should extend from 150 meters to above 20,000 meters. It is impractical to construct a single coil, even when equipped with a slider and sectionalizing switches to cover this entire range. It has become common practice to employ several sets of coils to cover this range. If coils without taps are used, the number required is so large that it is inconvenient to make the many changes required when working at a variety of wavelengths.

We have designed a set of four coils, each with four taps, which are particularly adapted for use in radio receiving sets. Although built with four different values of inductance they have the same physical dimensions, thus permitting two or more circuits to be coupled together. By working at the extreme limits of each coil it would be possible to cover the range referred to above with three sizes instead of four. The four sizes, however, give a much greater flexibility than do three.

The coils are approximately of Maxwellian shape. The winding is such as to keep the distributed capacitance a minimum. This is a particularly important feature in that it increases the range over which any one coil may be used, and what is more important, it increases the efficiency of the coil by keeping the dielectric losses a minimum. These coils are rugged in construction and attractive in appearance. The case is of polished oak with engraved bakelite panel. The metal parts are finished in polished nickel.



One very distinctive feature about these coils is that they are self-supporting and, accordingly, do not require any auxiliary mounting. Coupling between coils is varied by simply changing the distance between coils or by turning through any desired angle. The arrangement of taps is such as to give values of approximately 20%, 45%, 75% and 100% of the maximum inductance.

These coils are adapted for general laboratory use as well as for radio receiving sets. It is seldom necessary to use a complete set of twelve coils to cover all ranges from 150 to above 20,000 meters. A satisfactory 3-coil arrangement for this range is the following selection:

3 A Coils, 3 C Coils and 3 D Coils.

The ranges covered by these coils when used with one of our type 247 Condensers, which has a maximum capacitance of 1000 micro-microfarads, are shown in the following table:

Type	Max. Ind.	Resistance	Approximate Range	Code Word	Price
226A	0.3 M.H.	0.8 Ohm	140- 1000 meters	IMAGE	$6.00
226B	3.0 M.H.	0.9 Ohm	400- 3000 meters	IMBED	6.00
226C	20.0 M.H.	2.5 Ohms	1100- 8000 meters	IMBUE	6.00
226D	125.0 M.H.	30.0 Ohms	3000-24000 meters	IMPEL	6.00

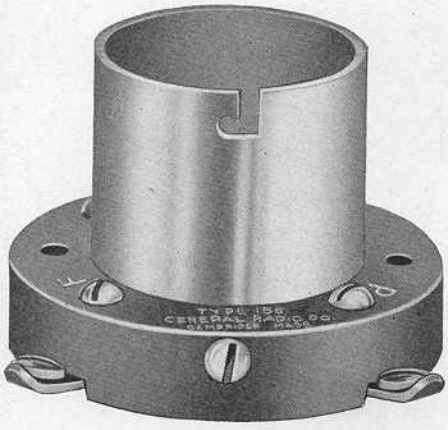
Dimensions 5" x 6" x 1½". Weight 2½ lbs.

Type 1002C

WESTERN ELECTRIC HEAD PHONES

This receiver, formerly known as the "P11," was adopted as standard by both the Army and Navy during the war. Combining as it does, sensitivity with great ruggedness, it is unusually well adapted to use in the laboratory and in the receiving station.

Price, complete with cord $12.00



Type 156

VACUUM TUBE SOCKET

A vacuum tube socket must be more than a tube mounting device. It must meet with the rigid requirements of radio. The best features of socket design are incorporated in our Type 156 vacuum tube socket.

The base is of heavy molded bakelite providing adequate insulation. The springs are of bronze, nickel finished. They are so arranged as to make positive contact on the sides of the tube prongs. As a wiping, spring contact is made, a clean, positive connection is assured.

These contact springs are heavy enough to carry, without arcing or heating, the heavy filament current of the 5-watt oscillator tubes.

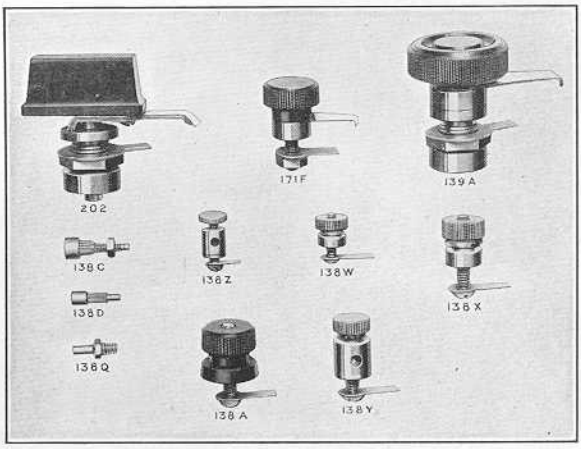
The tube and terminals of this socket are of brass with polished nickel finish. The arrangement of the base is such that this socket is adapted to any of the standard American four-prong tubes; including those transmitting tubes which have the locating pin placed 45 degrees away from normal.

Type 156 Socket $1.25

Code Word: "SOBER."

Dimensions 2½" x 2½" x 1¾". Weight 4 oz.

STANDARD PARTS



Experimental work frequently requires that the experimenter build special pieces of apparatus in his own laboratory. When this apparatus is of a permanent or semi-permanent nature, it is desirable to have the binding posts, switches and other parts of the best quality, and to have them match instruments already installed. Consequently, we are now listing many of the standard parts used in the assembly of our own instruments.

BINDING POSTS

Type	Description	Screw Size	Price
138A	Insulated	10-32	$0.25
138W	Nickel Plated Brass	6-32	0.12
138X	" " "	10-32	0.15
138Y	" " "	10-32	0.15
138Z	" " "	6-32	0.10

SWITCHES AND PARTS

Type	Description	Price
139A	Multiple Leaf Switch 1⅜" radius	$0.95
171F	Single Leaf Switch ⅞" radius	0.40
202	Low Contact Resistance Switch 1⅜" radius	1.25
138C	$\frac{5}{16}$" Contact for 139A or 202 Switches	0.05
138D	$\frac{3}{16}$" Contact for 171F Switch	0.04
138Q	Switch Stop	0.05

DIALS AND KNOBS

Type	Description	Price
137D	Moulded Knob (same as used on 239 Condenser)	$0.40
3″	Metal Dial (same as used on 239 Condenser)	0.50
137D	Knob and 3″ Dial Mounted	1.00
137EX	Small Extension Handle	0.35
139SN	Small Indicator Button (same as used on 239 Condenser)	0.15
3″	Dial, Complete with Knob, Extension Handle and Indicator Button	1.50
137F	Moulded Knob (same as used on 246 Condenser)	0.90
4″	Dial (same as used on 246 Condenser)	0.75
137F	Knob and 4″ Dial Mounted	1.85
101EX	8″ Extension Handle for 137F Knob	1.50
139LN	Large Indicator Button (same as used on 101 Condenser)	0.15
4″	Dial, Complete with Knob, Extension Handle and Indicator Button	3.50

The products of the General Radio Company cover a complete line of radio and electrical laboratory apparatus. Information and bulletins of special apparatus will be sent on request. Our line includes the following: Variable Air Condensers, Vernier Condenser, Standard Condensers, Decade Condensers, Variometers, Standards of Inductance, Standards of Resistance, Decade Resistance Boxes, Wavemeters, Decade Bridge, Capacity Bridge, Slide Wire Bridge, Audibility Meters, Hot Wire Meters, Galvanometers, Thermo-Couples, Telephone Transformer, Miscellaneous Apparatus.

All prices in this bulletin are strictly net, subject to change without notice, F. O. B. Cambridge, Mass. Cash should accompany orders from persons or firms with whom we have not already opened accounts. Unless otherwise instructed we shall use our own judgment regarding method of shipment.

This Bulletin replaces Bulletin 911

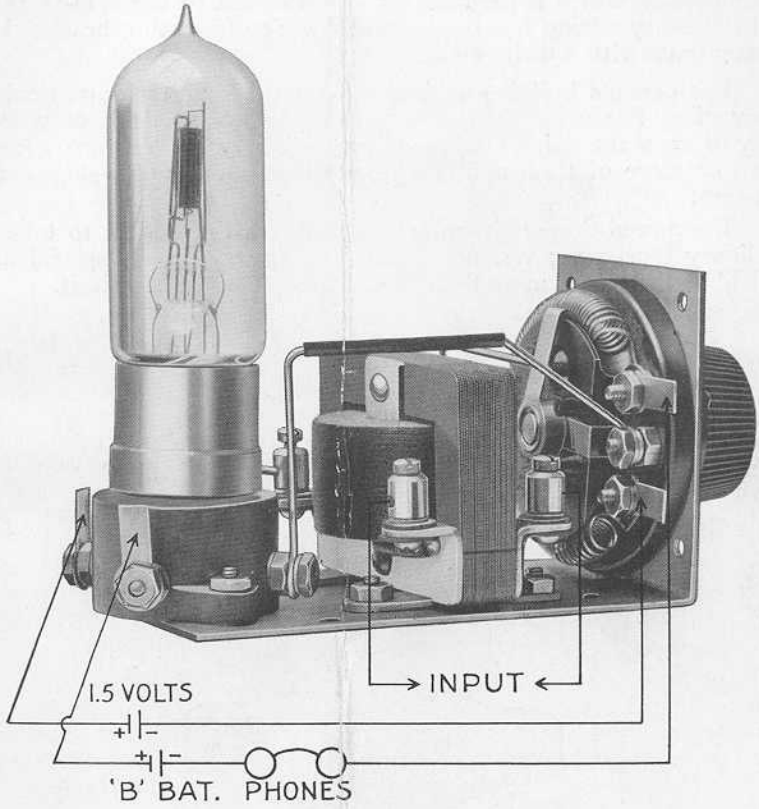
Standardize on General Radio Apparatus Throughout.

SHIP OWNERS RADIO SERVICE INC.
DISTRIBUTORS FOR

GENERAL RADIO COMPANY

MANUFACTURERS OF
ELECTRICAL AND RADIO LABORATORY APPARATUS
CAMBRIDGE, MASSACHUSETTS

BULLETIN 913 **DECEMBER 1922**



Type 300–A
AMPLIFIER UNIT

The recent tendency in radio has been towards the simplifying of instruments, yet retaining the same distance range. The WD-11 tube is a striking example of this.

Continuing this idea of simplicity we have developed a handy amplifier unit. This unit, as will be noted from the diagram, is self-contained except for power sources and receivers. It is already for connection to your detector set, be it a tube or a crystal unit. No storage

battery is required. A single dry cell serves for the filament battery, and a single unit such as the Eveready Type 763 for the plate battery.

This unit is so mounted that it may be used on a table or mounted behind a panel. When mounted behind a panel only the rheostat knob is visible in the front of the panel. The unit has mounting holes provided for either panel or table installation.

The parts of this unit amplifier are our new Type 282 Socket built for the WD-11 tubes, Type 255 Rheostat, and Type 231-A Amplifying Transformer, which is particularly well adapted to the WD-11 tubes. All necessary wiring has been provided. The mounting bracket is of heavy brass with a white nickel finish.

For persons building their own sets these units are particularly convenient because of the panel mounting feature. It is only necessary to screw the unit to the panel—no auxiliary brackets are required. Two or more of these units may be used to obtain multi-stage amplification.

If required these units may be supplied with a socket to take the ordinary four-prong vacuum tubes. The price of these special units would be fifty cents more than the standard WD-11 tube unit.

When you amplify—simplify.

Type 300–A Amplifier Unit.....$7.50

Dimensions 6″ x 2½″ x 2¾″. Weight 1½ lbs.

Code Word "AMAZE"

Tube or batteries are not included in the above price.

Type WD-11 Vacuum Tubes.....$6.50
Type 763 Eveready 22-volt Plate Battery..... 1.75

Type 282
WD–11 VACUUM TUBE SOCKET

The new, low, filament voltage Type WD-11 Vacuum Tubes will not fit the former standard American socket. The use of an adapter is inconvenient and expensive. Our new Type 282 Socket is designed expressly for the WD-11 tube.

This new socket is of moulded bakelite and is equipped with positive contact phosphor bronze springs. When the tube is inserted in the

socket the springs make contact against the sides of the prongs and do not depend upon the downward pressure of the tube. The four connection terminals are plainly marked. This socket is a characteristic General Radio quality product.

Type 282 Socket.....$0.80

Dimensions 2½" x 1¾" x 1". Weight 2 oz.

Code Word "SOLID"

Type 255
FILAMENT RHEOSTAT

For those who desire a rugged, smooth operating, yet inexpensive filament rheostat we have developed a new model to supplement our standard Type 214 Rheostat. Low price has been secured by simplicity in design rather than in the use of substitute materials.

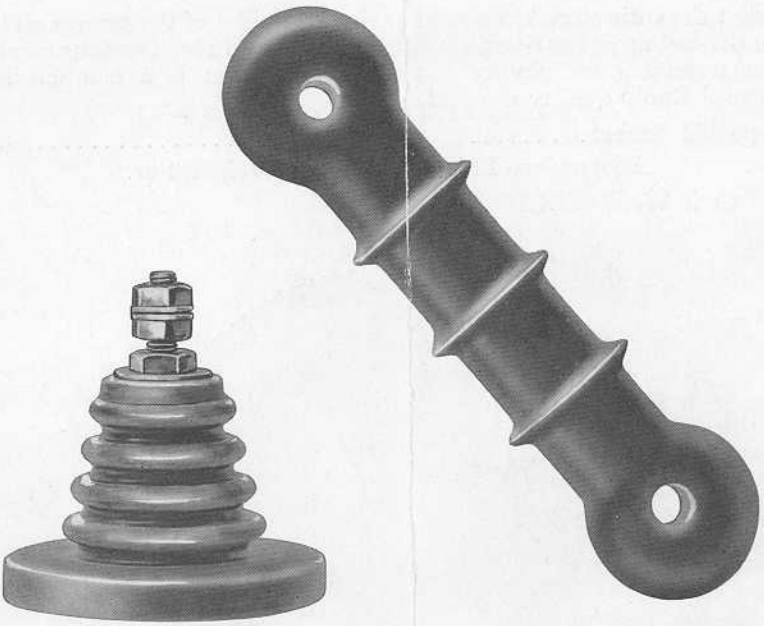
Like the larger rheostat the base is of moulded bakelite, not one of the inferior compositions so often substituted. The wire is wound in helical form and fits tightly in a groove in the base. The rheostat may be mounted either on the front or back of a panel. Terminals have been placed at each end of the resistance element so that the direction of rotation will be correct for either mounting. An off position is also provided.

The resistance is 6 ohms and the current carrying capacity 1.25 amperes. This combination is suitable for the UV-200, UV-201 and WD-11 tubes.

Type 255 Rheostat.....$1.00

Dimensions 2½" x 2½" x 1⅞". Weight 4 oz.

Code Word "RALLY"



Type 260 **Type 280**

Porcelain, which has losses but one-tenth that of the usual moulded materials, is rapidly becoming the standard material for insulators.

For antenna insulation, correctly designed porcelain strain insulators are to be preferred to other commercial types. The Type 280 Strain Insulator illustrated above will be found particularly satisfactory. It is made of carefully glazed brown porcelain and will withstand severe weather conditions.

Type 280 Strain Insulator.....$0.25

Dimensions 4½″ x 1⅛″ x 1″. Weight 4 oz.

Code Word "CRULLER"

Another convenient insulator is the Type 260 illustrated above. It may be used inside to support wiring or instruments, or may be used outside for supporting lead-in or ground wires. Two of these insulators with a threaded rod connecting them make an excellent lead in combination. As they are also constructed of glazed brown porcelain they may be used either indoors or out. Each insulator is equipped with nuts and washers assembled as shown in the cut. Three polished nickel mounting screws are also provided.

Type 260 Insulator.....$0.35

Dimensions 2⅛″ x 2⅛″ x 2″. Weight 4 oz.

Code Word "CONIC"

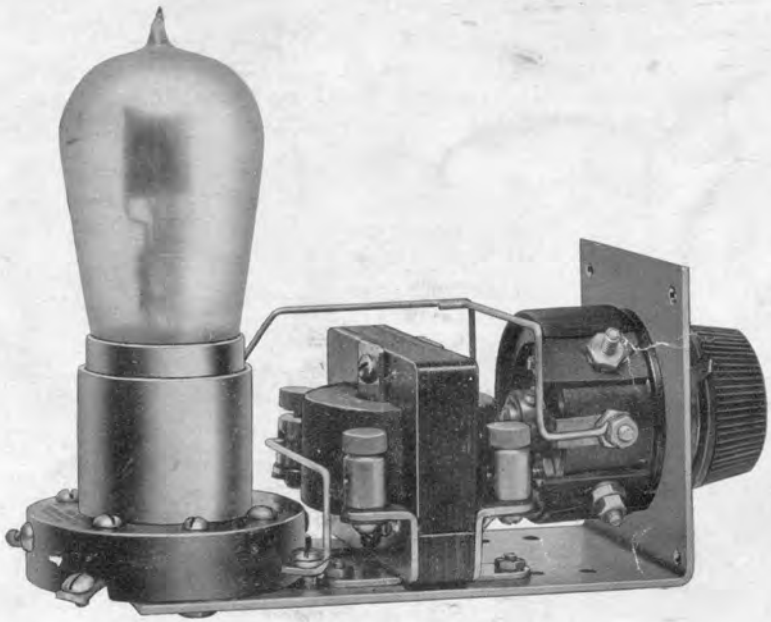
GENERAL RADIO COMPANY

MANUFACTURERS OF

ELECTRICAL AND RADIO LABORATORY APPARATUS

CAMBRIDGE, MASSACHUSETTS

BULLETIN 916 **OCTOBER 1923**



Type 300
AMPLIFIER UNIT

Simplicity in an amplifying unit is just as essential as in any other part of a radio receiver. The experienced radio man now recognizes that best results are obtained consistently by the correct use of properly designed instruments, rather than resorting to complex, and often unreliable, circuits.

With this idea of simplicity we have developed a convenient and efficient audio frequency amplifier unit. This unit is self-contained except for the batteries and receivers. It is ready for connection to your detector set, and it may be used with crystal or tube detector with equal efficiency.

This unit is so arranged that it may be used on a table or mounted behind a panel. When mounted behind a panel, only the rheostat knob is visible in front of the panel. Convenient mounting holes are provided for either panel or table installation.

For persons building their own sets, these units are very convenient because of the panel mounting feature. As the bracket is self-supporting, it is only necessary to screw the unit to the panel. Two or more of these units may be used to obtain multi-stage amplification.

The parts used in this [illegible] our standard instruments, a detailed description of which will be found in the following pages of this bulletin. All necessary wiring has been provided. The mounting bracket is of heavy brass with a white nickel finish. With each unit there is supplied a sheet showing a wiring diagram and giving operating instructions.

This unit is made up in two models, 300-D for the standard base tubes, such as the UV-201A, and 300-C for the UV-199 tubes. The only difference is in the socket. Both of these tubes may be operated from dry cells.

When you amplify—simplify.

Type 300-C Amplifier Unit for UV-199 Tubes.....$7.75
Dimensions 6 ½"x2 ½"x2 ¾". Weight 1 ½ lbs.
Code Word: "ARROW."

Type 300-D Amplifier Unit for Standard Base Tubes.....$8.25
Dimensions 6 ½"x2 ½"x2 ¾". Weight 1 ½ lbs.
Code Word: "ARSON."

For persons desiring to use WD-11 tubes the following special unit can be supplied:

Type 300-A Amplifier Unit for WD-11 Tubes.....$7.50
Dimensions 6 ½"x2 ½"x2 ¾". Weight 1 ½ lbs.
Code Word: "AMAZE."

Tubes and batteries are not included in the above prices.

Type 226
FOUR-STEP INDUCTOR

The tuned circuits of an experimental radio receiving station must be capable of operating over a wide range. They should extend from 150 meters to above 20,000 meters. It is impractical to construct a single coil, even when equipped with a slider and sectionalizing switches to cover this entire range. It has become common practice to employ several sets of coils to cover this range. If coils without taps are used, the number required is so large that it is inconvenient to make the many changes required when working at a variety of wavelengths.

We have designed a set of four coils, each with four taps, which are particularly adapted for use in radio receiving sets. Although built with four different values of inductance they have the same physical dimensions, thus permitting two or more circuits to be coupled together. By working at the extreme limits of each coil it would be possible to cover the range referred to above with three sizes instead of four. The four sizes, however, give a much greater flexibility than do three.

The coils are approximately of Maxwellian shape. The winding is such as to keep the distributed capacitance a minimum. This is a particularly important feature in that it increases the range over which any one coil may be used, and what is more important, it increases the efficiency of the coil by keeping the dielectric losses a minimum. These coils are [illegible] construction and attractive in appearance. The case is of polished oak with engraved bakelite panel. The metal parts are finished in polished nickel.

One very distinctive feature about these coils is that they are self-supporting and, accordingly, do not require any auxiliary mounting. Coupling between coils is varied by simply changing the distance between coils or by turning through any desired angle. The arrangement of taps is such as to give values of approximately 20%, 45%, 75% and 100% of the maximum inductance.

These coils are adapted for general laboratory use as well as for radio receiving sets. It is seldom necessary to use a complete set of twelve coils to cover all ranges from 150 to above 20,000 meters. A satisfactory 3-coil arrangement for this range is following selection:

3 A Coils, 3 C Coils and 3 D Coils.

The ranges covered by these coils when used with one of our Type 247 Condensers, which has a maximum capacitance of 1000 micro-microfarads, are shown in the following table:

Type	Max. Ind.	Resistance	Approximate Range	Code Word	Price
226A	0.3 M.H.	1.5 Ohms	140- 1000 Meters	IMAGE	$6.00
226B	3.0 M.H.	4.5 Ohms	400- 3000 Meters	IMBED	6.00
226C	20.0 M.H.	18.0 Ohms	1100- 8000 Meters	IMBUE	6.00
226D	125.0 M.H.	75.0 Ohms	3000-24000 Meters	IMPEL	6.00

Dimensions 5″x6″x1 ½″. Weight 2 ½ lbs.

Type 247
VARIABLE AIR CONDENSER

Experimental radio receiving sets require condensers whose quality is high and whose price is reasonable. It is easy to manufacture low-priced condensers as is evidenced by the large number now available. It is more difficult, however, to construct a condenser which is electrically and mechanically good, and yet at the same time to keep the cost of construction low.

For many years the subject of dielectric losses and condenser design has been studied in the Research Laboratory of the General Radio Company. This study has been carried on primarily in order to obtain data for the design of special condensers built to the exacting standards of scientific research work. With this information available, and with our experience in the design of laboratory instruments, we have been able to design a condenser of unusual merit for radio work and, at the same time, to keep its cost of construction remarkably low.

The value of a good condenser in a receiving set is not always fully appreciated. The dielectric losses of the condenser are equivalent to adding a series resistance in the oscillating circuit. To add a series resistance in the oscillating circuit means loss of energy which, in turn, means broad tuning and diminished signal strength. It is thus important that the dielectric losses in condensers be kept low. In this condenser these losses are kept low by using only a high-grade hard rubber for the solid dielectric. They are further kept low by using only a small quantity of this dielectric and so placing it with respect to the electrostatic field that the dielectric hysteresis losses are kept a minimum.

This is just one of the points which have received careful attention in the design of this condenser. Other important features include the following:

CAPACITY SCALE: In addition to the regular degree graduations of the etched metal dial, this dial has marked on it a scale showing capacities in micromicrofarads. This is a unique and valuable feature for radio receiving condensers, and it enables the operator to know at all times just what capacity he is using.

PLATES SOLDERED TOGETHER: In order that the plate resistance may be kept constant and that the capacity always will remain the same the plates of each unit of the condenser are soldered together.

HEAVY BRASS PLATES: The plates are of heavy sheet brass adequately spaced to prevent short-circuiting. Rugged plates of good conductivity are very desirable features in condenser construction.

BEARINGS: A special type spring bearing is used to insure good contact being made with the rotary plates. With this special type of bearing the tension always remains the same, and there is no chance for the rotary plate unit to loosen as the bearing wears. These bearings are so arranged that all the thrust is on one bearing, so that there is no danger of the condenser short-circuiting or changing its capacity if the distance between the bearings becomes changed.

LOW ZERO CAPACITY: The zero capacity of this condenser is approximately 20 micromicrofarads. This low value makes a wide range of wavelengths possible.

METAL CASE GROUNDED TO ROTARY PLATES: The condenser is mounted in a metal case finished with our black crystalline finish, the same as is used on our most expensive laboratory instruments. This case is grounded to the rotary plates, thus shielding the condenser and eliminating many of the disturbing effects due to bringing the hand near the condenser.

The fine adjustment required in tuning to continuous wave and broadcasting stations has made some form of fine capacity adjustment necessary. The common method of connecting a second or vernier condenser of low capacity in parallel with the main condenser has the objection that two adjustments are required for each setting. We have overcome this objection and provided a positive control throughout the entire range of the condenser by attaching a gear and pinion. By a single setting a finer adjustment is now possible than with the older two-adjustment vernier combination.

Do not deny your receiving set the advantages of a scientifically designed condenser.

SIZES: Although the demand is largely for 500 micromicrofarad sizes this condenser is also made in two other convenient sizes; namely, 1000 and 250 micromicrofarads. For nearly all work the 500 micromicrofarad size is to be preferred. In some circuits a smaller condenser is required in order to give a finer adjustment. Here the 250 micromicrofarad size should be used. In a few rare cases where a fine adjustment is not required a larger condenser is sometimes necessary. The 1000 micromicrofarad size is used in those cases.

USES: The low resistance feature of this condenser gives it a much wider range of uses than with the ordinary condenser. This condenser will be found especially valuable in tuning low resistance antenna circuits, in a loop receiver circuit, in a wavemeter and in a radio filter. In continuous wave transmitting sets they make very satisfactory antenna series condensers. The 250 and 500 micromicrofarad sizes will stand peak voltages of 1000, and the 1000 micromicrofarad size 500 volts.

Type 247A 1000 MMF. Mounted. Without gear.....$6.75
Dimensions 5″x5″x4 ½″. Weight 1 ¾ lbs.
Code Word: "CRONY."

Type 247B 1000 MMF. Panel mounting. Without gear.....$4.50
Dimensions 4″x4″x4 ⅛″. Weight 1 lb.
Code Word: "CRUEL."

Type 247C 1000 MMF. Mounted. With gear.....$8.50
Dimensions 5″x5″x4 ½″. Weight 1 ¾ lbs.
Code Word: "CYCLE."

Type 247D 1000 MMF. Panel Mounting. With gear.....$6.25
Dimensions 4″x4″x4 ⅛″. Weight 1 lb.
Code Word: "CUBIT."

Type 247E 500 MMF. Mounted. Without gear.....$5.50
Dimensions 5″x5″x4 ½″. Weight 1 ¾ lbs.
Code Word: "COUPE."

Type 247F 500 MMF. Panel Mounting. Without gear.....$3.25
Dimensions 4″x4″x4 ⅛″. Weight 1 lb.
Code Word: "COCOA."

Type 247G 500 MMF. Mounted. With gear.....$7.25
Dimensions 5″x5″x5 ⅛″. Weight 2 lbs.
Code Word: "COLIC."

Type 247H 500 MMF. Panel Mounting. With gear.....$5.00
Dimensions 4″x4″x4 ⅛″. Weight 1 ⅛ lbs.
Code Word: "COMIC."

Type 247J 250 MMF. Mounted. Without gear.....$5.25
Dimensions 5″x5″x4 ½″. Weight 1 ½ lbs.
Code Word: "CANON."

Type 247K 250 MMF. Panel Mounting. Without gear.....$3.00
Dimensions 4″x4″x4″. Weight ⅞ lb.
Code Word: "CARGO."

Type 247L 250 MMF. Mounted. With gear.....$7.00
Dimensions 5″x5″x4 ½″. Weight 1 ½ lbs.
Code Word: "CAROM."

Type 247M 250 MMF. Panel Mounting. With gear.....$4.75
Dimensions 4″x4″x4″. Weight ⅞ lb.
Code Word: "CIGAR."

Knob and dial, without capacity graduations, and indicator button for use with unmounted condenser.....$0.50

Gear, pinion, pinion shaft and mounting supports, per set.....$1.75

Type 247W
WAVEMETER AND FILTER

A very convenient direct-reading wavemeter, range 150 to 500 meters, is formed by a special Type 247 condenser connected to an inductance unit. A nearly uniform wavelength scale, etched directly on the condenser dial, results from the use of specially shaped condenser plates. The accuracy of calibration is 2%.

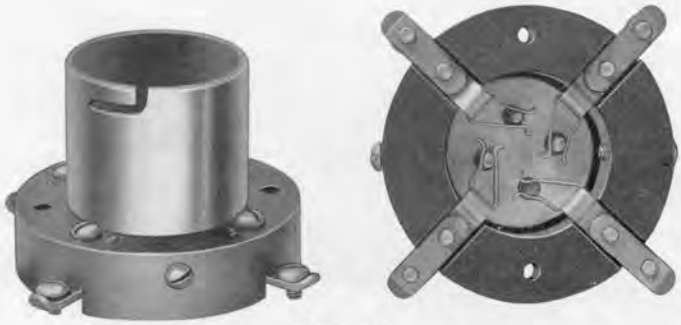
The selectivity of a receiving set is greatly improved by a Radio Filter. The Type 247W wavemeter is ideally adapted for this purpose, since it is provided with a variable coupling coil located beneath the wavemeter winding. This coil may be connected either in series or parallel with the receiving set.

A single interfering broadcasting station may be cut out by using the series connection. The parallel filter is used to reduce interference from spark stations, static, and similar sources. A full set of instructions accompany each instrument.

Type 247W Wavemeter and Filter $10.00
Dimensions 5″x4 ½″x8″. Weight 3 lbs.
Code Word: "WAGON."

VACUUM TUBE SOCKETS

A vacuum tube socket must be more than a tube mounting device. It not only must hold the tube securely to prevent vibration, but also must make firm electrical contact with the four tube prongs. The best features of socket design are incorporated in our vacuum tube sockets.



Type 156

Type 156 Socket

This socket is for the so-called standard American four-prong tubes. It fits such tubes as the UV-200, UV-201A, UV-202 and WD-12. The base is of heavy moulded bakelite providing adequate insulation. The springs are of bronze, nickel finished. They are so arranged as to make positive contact on the sides of the tube prongs. As a wiping, spring contact is made, a clean, positive connection is assured. The tube is of heavy brass with high polished nickel finish.

By loosening two screws and rotating the base this socket will fit the VT-2 tubes. Attention is called to the fact that not only will the socket fit the VT-2 tubes, but that the contact springs are heavy enough to carry, without arcing or heating, the heavy filament currents of these and other five-watt oscillator tubes.

Type 282 Socket

The WD-11 tubes will not fit the standard socket. The use of an adapter is inconvenient and expensive. A socket designed to fit the tube is more satisfactory electrically and at the same time more economical.

The Type 282 socket is designed for use with the WD-11 tube. This socket is of moulded bakelite and is equipped with positive contact phosphor bronze springs. When the tube is inserted in the socket the springs make contact against the sides of the prongs and do not depend upon the downward pressure of the tube. The four connection terminals are plainly marked.

Type 282

Type 299 Socket

The UV-199 tube is similar to the WD-11 in that it requires a special socket. The current used in this tube is lower than that required by the other tubes. The prongs are shorter and the general dimensions smaller than on other tubes now available. These features have all been cared for in our Type 299 socket built for the UV-199 tube.

This socket is of moulded bakelite and has its terminals plainly marked. The springs are of phosphor bronze and are made rugged to insure good contact with the tube prongs.

The mounting holes of this socket are spaced the same as those of the 156 and 282 sockets. This feature makes it preferable to change the socket rather than to bother with an adapter when a permanent change in type of tube is desired.

Type 299

Type 156 Socket $1.00
Dimensions 2 ½"x2 ½"x1 ¾". Weight 4 oz.
Code Word: "SOBER."

Type 282 Socket $0.60
Dimensions 2 ½"x1 ¾"x1". Weight 2 oz.
Code Word: "SOLID."

Type 299 Socket $0.75
Dimensions 2 ⅜"x1 ⅜"x1". Weight 2 oz.
Code Word: "STORY."

Type 231A
AMPLIFYING TRANSFORMER

The remarkable results obtained in long distance radio communication in recent years have been due largely to amplification made possible by the use of vacuum tubes. The simplest and most common type of amplification is that of the detected signals, and is commonly called audio frequency amplification.

In order to get the maximum of results with this type of amplification, the impedance of the grid circuit of the amplifier tube must be adjusted to the impedance of the previous detector or amplifier tube output circuit. This can best be accomplished by means of a suitably designed transformer. Our Type 231A transformer was built specifically to meet this situation. The primary receives the maximum amount of energy and delivers it undistorted in waveform and at the correct potential to the grid of the amplifying tube.

The core construction is such that there is little tendency for the setting up of external fields, with the resultant howling in the audio frequency circuit. The distributed capacity of the secondary is low, so that the maximum potential is obtained on the grid of the tube.

The primary has a direct current resistance of 1100 ohms, an alternating current resistance at 1000 cycles of 11,000 ohms, and a reactance at this frequency of 50,000 ohms. These figures for the secondary are 5500, 130,000, and 600,000 ohms respectively. These constants make the transformer particularly adapted to the UV-199, UV-201A, WD-11, WD-12 and tubes of similar impedance.

In order to obtain the best results from an amplifying transformer, certain precautions should be observed. Since what is wanted is the production of the maximum potential, or rather change of potential on the grid of the amplifying tube, it is best to connect the grid to the outside terminal of the secondary of the transformer. This is because the outer portion of the secondary has smaller capacity to ground than the inner portion, due to the proximity of the latter to

the primary winding, which is connected to the filament and other low potential parts of the circuit. This capacity effect increases with frequency and therefore reduces the intensity of high notes proportionately more than low ones, thus tending to cause distortion. Howling, or oscillation at audio frequencies, is caused by coupling (either electrostatic or magnetic) of the amplifier grid to some other part of the circuit, and is more troublesome with two or more stages of amplification than with one. If the electrostatic and magnetic couplings are made to oppose each other, the tendency to oscillate is minimized, and when a transformer is connected into a circuit it is worth while to reverse the leads to the primary to see which connection is better. In some cases, the oscillations are above audibility, but the strength of signals is reduced, nevertheless.

In an oscillating detector circuit the capacity of the telephone cords (which is of the order of 75 MMF.) is often sufficient to by-pass the radio frequency current around the high inductance of the phones, but when the primary of an amplifying transformer is substituted for the phones, it should be shunted with a condenser of a few hundred micromicrofarads or more.

Aside from its excellent electrical characteristics, this transformer is well designed mechanically. It is compact, and by means of the four projecting feet, each with a screw hole, may be mounted in any position. The core and coil are finished in black, while the brackets and binding posts are nickeled. Particular attention is called to the accessibility of both the binding posts and the mounting brackets.

Every transformer is guaranteed.

Type 231A Amplifying Transformer $5.00
Dimensions 2 5/8"x2 1/2"x2 1/2". Weight 1 lb.
Code Word: "TUTOR."

Type 231M
MODULATION TRANSFORMER

This transformer is similar in general design to the Type 231A amplifying transformer, the only difference being in the winding. Its windings have been designed particularly for use with the Radiotron UV-202 five-watt transmitting tubes and other tubes of similar characteristics. To get the maximum modulation, the modulating device should have an impedance somewhat greater than the input impedance of the tube. This impedance is of the order of several hundred thousand ohms, while that of a telephone transmitter is but a few ohms. A modulation transformer serves to adapt the telephone transmitter impedance to that of the input circuit of the tube. The success of a radio telephone installation depends not only on the value of the antenna current, but also on how completely that current is modulated. Our Type 231M transformer has been designed to give the maximum modulation which is possible without distortion.

Type 231M Modulation Transformer $5.00
Dimensions 2 5/8"x2 1/2"x2 1/2". Weight 1 lb.
Code Word: "TUNIC."

Types 214 and 301
RHEOSTATS AND POTENTIOMETERS

Rheostats used in vacuum tube circuits must be so constructed and the contact so arranged that there is no possibility of a momentary opening of the circuit, or a sudden change of resistance in the circuit. Either of these would result in an objectionable click in the telephone receivers. The resistance should also change uniformly throughout the entire range of the rheostat. This is necessary to secure the same degree of control for all working conditions of the battery. With the tubes now available, and with the gradual change of resistance provided by our Types 214 and 301 rheostats, no vernier attachments are necessary.

Type 214

The resistance units of both types of rheostats are tightly wound on specially treated fibre strips. Moulded bakelite, not an inferior substitute, is used for the base. The tapered moulded knob is provided with a pointer indicating the position of the contact arm. The shaft is ¼″ in diameter and is arranged to fit panels up to ⅜″ thick.

Where the best in rheostat construction is desired, and for laboratory use, the Type 214 is recommended. This rheostat is made in two types, 214A for back of panel mounting and 214B for front of panel or table use.

Although smaller in size, the Type 301 rheostat is similar in general construction to the Type 214. It is a practical rheostat for general use.

Many of the circuits now in common use require potentiometers to control the grid potential. Both the Types 214 and 301 are supplied with high resistance windings and a third connection to enable them to be used as potentiometers.

Type 214 Rheostat.....$2.25

Dimensions 3″d.x2 ¼″. Weight 7 oz.

Resistance	Current	CODE WORD Type 214A Back of Panel	Type 214B Front of Panel
2 ohms	2.5 amp.	RUDDY	RUMOR
7 ohms	1.5 amp.	RURAL	RUSTY
20 ohms	.75 amp.	RAZOR	READY
50 ohms	.5 amp.	RAPID	RAVEL

Type 214, 400 Ohm Potentiometer.....$3.00

Dimensions 3″d.x2 ¼″. Weight 7 oz.

Code Word, Type 214A, Back of Panel Mtg.: "ROSIN."

Code Word, Type 214B, Front of Panel Mtg.: "ROWEL."

Type 301 Rheostat $1.25

Dimensions 2″x1 ¾″x2 ⅛″. Weight 4 oz.

Resistance	Current	Code Word
10 ohms	.75 amp.	REMIT
30 ohms	.5 amp.	RENEW

Type 301

Type 301, 200 Ohm Potentiometer.....$1.25

Dimensions 2″x1 ¾″x2 ⅛″. Weight 4 oz.

Code Word: "REBUS."

In ordering be sure to specify resistance desired.

Type 127
HOT WIRE AMMETERS

The exacting requirements imposed on transmitting stations make it necessary that current measurements be made to insure operation at maximum efficiency. Since it is equally accurate on direct current or alternating current of any frequency a hot wire ammeter is the most convenient meter for this service. Not only may it be used for measuring radiation currents, but it may also be used to measure filament currents, storage battery charging rates, plate currents and for many other purposes. It is important that the meter should have low impedance, and it should be rugged and reliable. The Type 127 Hot Wire Ammeters are built to meet these requirements. During the recent war the U. S. Army and Navy used large numbers of these meters.

The expanding strip in these meters is of thin platinum, so as to prevent oxidation. It is so proportioned that it works at a low temperature and is of low resistance. These are two highly desirable features, since the former permits reasonable overloading without burning out, and the latter minimizes the losses.

The type of multiplying action is such that a more uniform scale is obtained than with many hot wire meters. These meters have been corrected for temperature so that there is very little shift of zero, and this is easily taken care of by the knurled adjusting screw.

These instruments are made in three types, the flush mounting for use on panels, the front-of-board mounting for use on switchboards,

and the portable type for general use. In mounting the flush type of meter an opening in the panel 2 5/8 inches in diameter should be provided.

In mounting the front-of-board type allowance should be made for a case 3 inches in diameter. The flush type meters are mounted in metal cases finished in black japan, while the front-of-board and portable types have cases of moulded bakelite.

Type 127A

	Range	Code Word	Case	Price
100	Milli-Amps.	MEDAL	Flush Mounting	$9.00
250	Milli-Amps.	MERCY	Flush Mounting	7.75
500	Milli-Amps.	MERIT	Flush Mounting	7.75
1	Ampere	MERRY	Flush Mounting	7.75
1.5	Amperes	MINUS	Flush Mounting	7.75
2.5	Amperes	MINOR	Flush Mounting	7.75
5	Amperes	MINIM	Flush Mounting	7.75
10	Amperes	MINNY	Flush Mounting	7.75
	Galvanometer	MITER	Flush Mounting	7.25

Dimensions 3″d.x1 ½″. Weight 9 ½ oz.

Type 127B

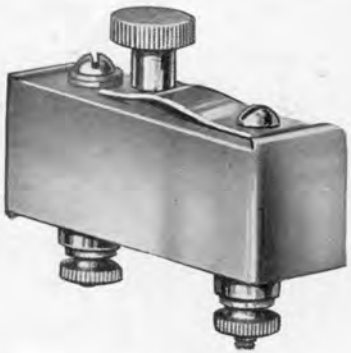
100	Milli-Amps.	MAYOR	Front of Board	$9.00
250	Milli-Amps.	MADAM	Front of Board	7.75
500	Milli-Amps.	MAJOR	Front of Board	7.75
1	Ampere	MANOR	Front of Board	7.75
1.5	Amperes	MISTY	Front of Board	7.75
2.5	Amperes	MAPLE	Front of Board	7.75
5	Amperes	MATIN	Front of Board	7.75
10	Amperes	MAXIM	Front of Board	7.75
	Galvanometer	MAGIC	Front of Board	7.25

Dimensions 3″d.x1 ½″. Weight 9 oz.

Type 127C

	Range	Code Word	Case	Price
100	Milli-Amps.	MUGGY	Portable	$10.00
250	Milli-Amps.	MOCHA	Portable	9.00
500	Milli-Amps.	MOGUL	Portable	9.00
1	Ampere	MOLAR	Portable	9.00
2.5	Amperes	MOTOR	Portable	9.00
5	Amperes	MUMMY	Portable	9.00
10	Amperes	MUSTY	Portable	9.00
	Galvanometer	MOTTO	Portable	8.50

Dimensions 3″x4″x1 ½″. Weight 10 ½ oz.



Type 178
HIGH FREQUENCY BUZZER

This buzzer has been designed for both laboratory and radio use. It combines pureness of tone, simplicity of adjustment and durability.

The frequency is approximately 800 cycles, but depends on the setting of the knurled adjusting screw. As the current required for the operation of the buzzer is approximately only 30 milli-amperes, it may be operated for long periods of time from small batteries. One dry cell will provide sufficient potential to operate this buzzer satisfactorily.

One of the noteworthy features of this buzzer is its freedom from sparking. This is important where pure tones are required. This feature makes the buzzer particularly adapted as a supply source for bridge measurements and for continuous wave telegraph modulation.

Type	Mounting	Code Word	Price
178A	Above Panel	BEFOG	$2.00
178B	Below Panel	BEGET	2.00

Dimensions 2″x1 ¾″x1″. Weight 3 oz.

Type 260 *Type 280*

Porcelain, which has losses but one-tenth that of the usual moulded materials, is rapidly becoming the standard material for insulators.

For antenna insulation, correctly designed porcelain strain insulators are to be preferred to other commercial types. The Type 280 Strain Insulator, illustrated above, will be found particularly satisfactory. It is made of carefully glazed brown porcelain and will withstand severe weather conditions.

Type 280 Strain Insulator.....$0.25
Dimensions 4 ½″x1 ⅛″x1″. Weight 4 oz.
Code Word: "CRULLER."

Another convenient insulator is the Type 260, illustrated above. It may be used inside to support wiring or instruments, or may be used outside for supporting lead-in or ground wires. Two of these insulators with a threaded rod connecting them make an excellent lead in combination. As they are also constructed of glazed brown porcelain they may be used either indoors or out. Each insulator is equipped with nuts and washers assembled, as shown in the cut. Three polished nickel mounting screws are also provided.

Type 260 Insulator.....$0.25
Dimensions 2 ⅛″x2 ⅛″x2″. Weight 4 oz.
Code Word: "CONIC."

STANDARD PARTS

Experimental work frequently requires that the experimenter build special pieces of apparatus in his own laboratory. When this apparatus is of a permanent or semi-permanent nature, it is desirable to have the binding posts, switches and other parts of the best quality, and to have them match instruments already installed. Consequently, we are now listing many of the standard parts used in the assembly of our own instruments.

BINDING POSTS

Type	Description	Screw Size	Price
138A	Insulated	10-32	$0.25
138W	Nickel Plated Brass	6-32	0.12
138X	" " "	10-32	0.15
138Y	" " "	10-32	0.15
138Z	" " "	6-32	0.10

SWITCHES AND PARTS

Type	Description	Price
139A	Multiple Leaf Switch 1⅜" Radius	$0.95
171F	Single Leaf Switch ⅞" Radius	0.40
202	Low Contact Resistance Switch 1⅜" Radius	1.25
138C	5/16" Contact for 139A or 202 Switches	0.05
138D	5/16" Contact for 171F Switch	0.04
138Q	Switch Stop with Nut	0.05

DIALS AND KNOBS

Type	Description	Price
137D	Moulded Knob (same as used on 247 Condenser)	$0.30
3″	Metal Dial (same as used on 239 Condenser)	0.50
137D	Knob and 3″ Dial Mounted	0.90
137EX	Small Extension Handle	0.35
139SN	Small Indicator Button (same as used on 239 Condenser)	0.15
3″	Dial, Complete with Knob, Extension Handle and Indicator Button	1.40
137H	Moulded Knob (same as used on 246 Condenser)	0.90
4″	Dial (same as used on 246 Condenser)	0.75
137H	Knob and 4″ Dial Mounted	1.85
101EX	8″ Extension Handle for 137F Knob	1.50
139LN	Large Indicator Button (same as used on 246 Condenser)	0.15
4″	Dial, Complete with Knob, Extension Handle and Indicator Button	3.50
137J	Moulded Knob (same as used on 301 Rheostat)	0.25
137K	Moulded Knob (same as used on 247 Condenser Vernier)	0.25

137D-H-J Knobs for ¼″ Shafts. 137K Knob tapped 10-32 thread

The products of the General Radio Company include not only those listed in this bulletin, but also radio and electrical laboratory apparatus. Information and bulletins of special apparatus will be sent on request. These instruments include: Low Loss Variable Air Condensers, Precision Condenser, Vernier Condenser, Decade Condenser, Variometers, Standards of Inductance, Standards of Resistance, Decade Resistance Boxes, Impedance Bridge, Capacity Bridge, Slide Wire Bridge, Audibility Meter, Wavemeters, Ratio Arm Box, Galvanometer Shunt, Hot Wire Ammeters, Recorders, Amplifiers and Miscellaneous Apparatus.

All prices in this bulletin are strictly net, subject to change without notice, F. O. B. Cambridge, Mass. Cash should accompany orders from persons or firms with whom we have not already opened accounts. Unless otherwise instructed we shall use our own judgment regarding method of shipment.

This Bulletin replaces Bulletins 914 and 915

Standardize on General Radio Apparatus Throughout

The General Radio Co. was incorporated in 1915 for the purpose of developing and manufacturing certain special radio instruments. It started as a going concern and it was in effect a division of another electrical manufacturing company. The conditions brought about by the war made it advisable to drop all connections with the original company. Since that time there has been no connection with any other company.

Electrical and radio measuring instruments have been specialized in. Low loss condenser design has received much attention, and this company was the first in this country to supply such condensers commercially. It was also the first company to supply commercially closed core audio frequency transformers. It was instrumental in obtaining the adoption of the standard four-prong vacuum tube socket.

The instruments manufactured by this company are the result of careful engineering design. In many cases they represent the result of years of development work and investigation in our laboratory. It has been the aim of this company to contribute only quality instruments to the radio and electrical industry. Every instrument is guaranteed.

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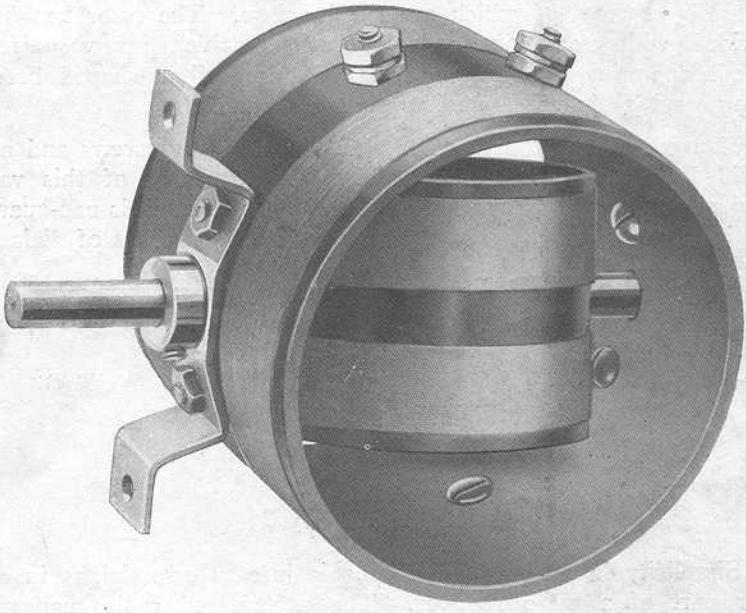
GENERAL RADIO COMPANY

MANUFACTURERS OF

ELECTRICAL AND RADIO LABORATORY APPARATUS

CAMBRIDGE, MASSACHUSETTS

BULLETIN 917 **MARCH 1924**



Type 268

VARIO COUPLER

Broadcast reception is nearly all included by the wavelength band of 150 to 600 meters. The circuits designed for this class of reception nearly all require an efficient, compact vario coupler. Such an instrument is available in the Type 268.

Both the rotor and the stator forms are of moulded bakelite and are cylindrical in shape. A wide separation is provided between the rotor and the stator in order to permit the extremely loose coupling so often required. The windings are of green silk covered wire which, with the polished bakelite forms, gives the vario coupler an unusually attractive appearance. The metal parts are finished in nickel.

It was formerly considered good practice to have a large number of taps in vario coupler primaries. In many recent receiving sets taps have been omitted entirely. With the condensers and circuits now in general use taps on a vario coupler are really of little importance. There are times, particularly in controlling regeneration, when a single center tap is an advantage. Thus to make this vario coupler efficient, yet simple in operation, a single center tap has been brought out on the stator.

Much of the success of a vario coupler depends on its mechanical features, foremost of which are the bearings. The rotor has been provided with exceptionally long bearings which insure uniform smooth operation over long periods of use. Star shaped bronze spring washers insure a perfect electrical contact.

Convenient brackets together with the mounting screws and nuts provided with each instrument makes the mounting of this vario coupler on a panel a very simple operation. The shaft is one-quarter inch in diameter and long enough to take nearly all types of dials.

Type 268 Vario Coupler $3.50
Dimensions 4"x4"x2½". Weight 8 oz.
Code Word: "VALET."

Type 300

AMPLIFIER UNIT

Simplicity in an amplifying unit is just as essential as in any other part of a radio receiver. The experienced radio man now recognizes that best results are obtained consistently by the correct use of properly designed instruments.

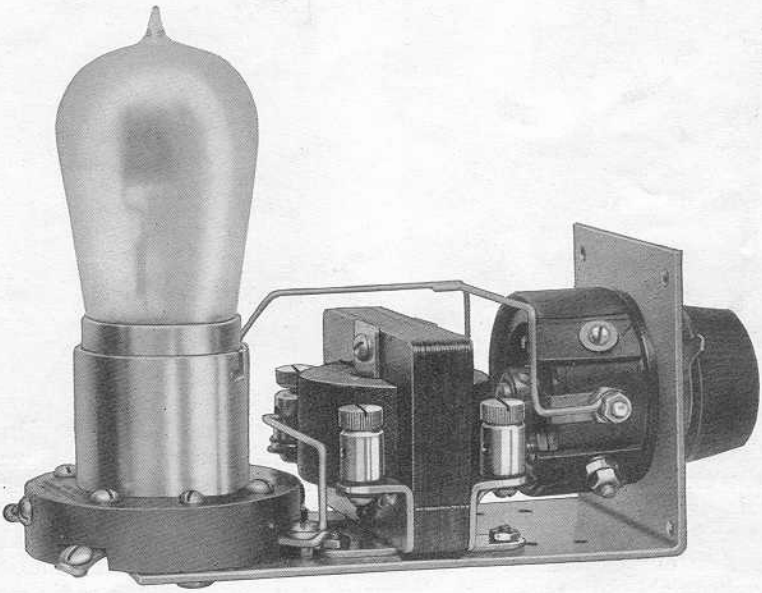
With this idea of simplicity we have developed a convenient and efficient audio frequency amplifier unit. This unit is self-contained except for the batteries and receivers. It is ready for connection to your detector set, and it may be used with crystal or tube detector with equal efficiency.

This unit is so arranged that it may be used on a table or mounted behind a panel. When mounted behind a panel, only the rheostat knob is visible in front of the panel. Convenient mounting holes are provided for either panel or table installation.

For persons building their own sets, these units are very convenient because of the panel mounting feature. As the bracket is

self-supporting, it is only necessary to screw the unit to the panel. Two or more of these units may be used to obtain multi-stage amplification.

The parts used in this unit are our standard instruments, a detailed description of which will be found in the following pages of this bulletin. All wiring except external connections has been provided. The mounting bracket is of heavy brass with a white nickel finish. With each unit there is supplied a sheet showing a wiring diagram and giving operating instructions.



This unit is made up in two models, 300-D for the standard base tubes, such as the UV-201A, and 300-C for the UV-199 tubes. The only difference is in the socket. Both of these tubes may be operated from dry cells.

When you amplify—simplify.

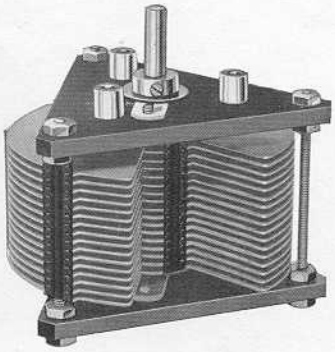
Type 300-C Amplifier Unit for UV-199 Tubes.....$7.75
Dimensions 6½"x2½"x2¾". Weight 1½ lbs.
Code Word: "ARROW."

Type 300-D Amplifier Unit for Standard Base Tubes.....$8.00
Dimensions 6½"x2½"x2¾". Weight 1½ lbs.
Code Word: "ARSON."

Tubes and batteries are not included in the above prices.

Type 247
VARIABLE AIR CONDENSER

Experimental radio receiving sets require condensers high in quality and reasonable in price. It is easy to manufacture low-priced condensers as is evidenced by the large number now available. It is more difficult, however, to construct a condenser which is electrically and mechanically good, and yet at the same time to keep the cost of construction low.



For many years the subject of dielectric losses and condenser design has been studied in the Research Laboratory of the General Radio Company. This study has been carried on primarily in order to obtain data for the design of special condensers built to the exacting standards of scientific research work. With this information available, and with our experience in the design of laboratory instruments, we have been able to design a condenser of unusual merit for radio work and, at the same time, to keep its cost of construction remarkably low.

The value of a good condenser in a receiving set is not always fully appreciated. The dielectric losses of the condenser are equivalent to adding a series resistance in the oscillating circuit. To add a series resistance in the oscillating circuit means loss of energy which, in turn, means broad tuning and diminished signal strength. It is thus important that the dielectric losses in condensers be kept low. In this condenser these losses are kept low by using only a high-grade hard rubber for the solid dielectric. They are further kept low by using only a small quantity of this dielectric and so placing it with respect to the electrostatic field that the dielectric hysteresis losses are kept a minimum.

This is just one of the points which have received careful attention in the design of this condenser. Other important features include the following:

CAPACITY SCALE: In addition to the regular degree graduations of the etched metal dial, this dial has marked on it a scale showing capacities in micromicrofarads. This is a unique and valuable feature for radio receiving condensers, and it enables the operator to know at all times just what capacity he is using.

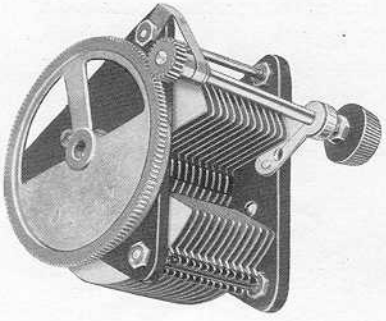
PLATES SOLDERED TOGETHER: In order that the plate resistance may be kept constant and that the capacity always will remain the same the plates of each unit of the condenser are soldered together.

HEAVY BRASS PLATES: The plates are of heavy sheet brass adequately spaced to prevent short-circuiting. Rugged plates of good conductivity are very desirable features in condenser construction.

BEARINGS: A special type spring bearing is used to insure good contact being made with the rotary plates. With this special type of bearing the tension always remains the same, and there is no chance for the rotary plate unit to loosen as the bearing wears. These bearings are so arranged that all the thrust is on one bearing, so that there is no danger of the condenser short-circuiting or changing its capacity if the distance between the bearings becomes changed.

LOW ZERO CAPACITY: The zero capacity of this condenser is approximately 20 micromicrofarads. This low value makes a wide range of wavelengths possible.

METAL CASE GROUNDED TO ROTARY PLATES: The condenser is mounted in a metal case finished with our black crystalline finish, the same as is used on our most expensive laboratory instruments. This case is grounded to the rotary plates, thus shielding the condenser and eliminating many of the disturbing effects due to bringing the hand near the condenser.



FINE ADJUSTMENT: The fine adjustment required in tuning to continuous wave and broadcasting stations has made some form of fine capacity adjustment necessary. The common method of connecting a second or vernier condenser of low capacity in parallel with the main condenser has the objection that two adjustments are required for each setting. We have overcome this objection and provided a positive control throughout the entire range of the condenser by attaching a gear and pinion.

SIZES: For nearly all work the 500 micromicrofarad size is to be preferred. In some circuits, however, a smaller condenser is required to give a finer adjustment. For these circuits the 250 micromicrofarad size is available.

USES: The low resistance feature of this condenser gives it a much wider range of uses than with the ordinary condenser. This condenser will be found especially valuable in tuning low resistance antenna circuits, in a loop receiver circuit, in a wavemeter and in a radio filter. Many of the advanced types of circuits such as the superheterodyne will only work satisfactorily when good quality condensers are used. In addition to their use in receiving sets these condensers make satisfactory antenna series condensers in continuous wave transmitting sets. They will stand peak voltages of 1000.

Do not deny your receiving set the advantages of a scientifically designed condenser.

Type 247E 500 MMF. Mounted. Without gear.....$5.50
Dimensions 5"x5"x4½". Weight 1¾ lbs.
Code Word: "COUPE."

Type 247F 500 MMF. Panel Mounting. Without gear.....$3.25
Dimensions 4"x4"x4⅛". Weight 1 lb.
Code Word: "COCOA."

Type 247G 500 MMF. Mounted. With gear.....$7.25
Dimensions 5"x5"x5⅛". Weight 2 lbs.
Code Word: "COLIC."

Type 247H 500 MMF. Panel Mounting. With gear.....$5.00
Dimensions 4"x4"x4⅛". Weight 1⅛ lbs.
Code Word: "COMIC."

Type 247J 250 MMF. Mounted. Without gear.....$5.25
Dimensions 5"x5"x4½". Weight 1½ lbs.
Code Word: "CANON."

Type 247K 250 MMF. Panel Mounting. Without gear.....$3.00
Dimensions 4"x4"x4". Weight ⅞ lb.
Code Word: "CARGO."

Type 247L 250 MMF. Mounted. With gear.....$7.00
Dimensions 5"x5"x4½". Weight 1½ lbs.
Code Word: "CAROM."

Type 247M 250 MMF. Panel Mounting. With gear.....$4.75
Dimensions 4"x4"x4". Weight ⅞ lb.
Code Word: "CIGAR."

Knob and dial, without capacity graduations, and indicator button for use with unmounted condenser.....$0.50

Gear, pinion, pinion shaft and mounting supports, per set.....$1.75

The capacity of the condenser must be specified when ordering gear and pinion parts.

Type 247W
WAVEMETER AND FILTER

A very convenient direct-reading wavemeter, range 150 to 500 meters, is formed by a special Type 247 condenser connected to an inductance unit. A nearly uniform wavelength scale, etched directly on the condenser dial, results from the use of specially shaped condenser plates. The accuracy of calibration is 2%.

The selectivity of a receiving set is greatly improved by a Radio Filter. The Type 247W wavemeter is ideally adapted for this purpose, since it is provided with a variable coupling coil located beneath the wavemeter winding. This coil may be connected either in series or parallel with the receiving set.

A single interfering broadcasting station may be cut out by using the series connection. The parallel filter is used to reduce interference from spark stations, static, and similar sources. A full set of instructions accompany each instrument.

Type 247W Wavemeter and Filter $10.00

Dimensions 5″x4½″x8″. Weight 3 lbs.

Code Word: "WAGON."

When longer wavelengths are desired an additional combination filter and wavemeter coil so arranged that the wavelength readings on the condenser dial are doubled may be supplied. This coil has a range, accordingly, of from 300 to 1000 meters.

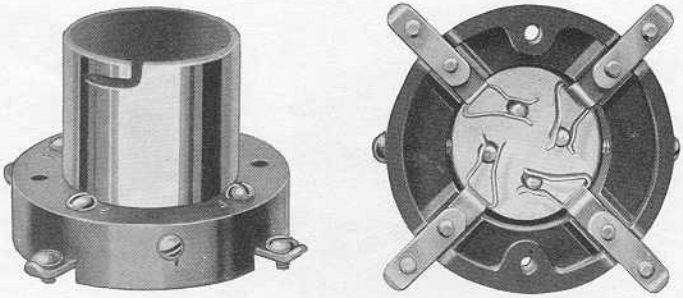
Type 247-W2 Extension Coil $3.00

Dimensions 4″x4″x3″. Weight 8 oz.

Code Word: "VOCAL."

VACUUM TUBE SOCKETS

A vacuum tube socket must be more than a tube mounting device. It not only must hold the tube securely to prevent vibration, but also must make firm electrical contact with the four tube prongs. The best features of socket design are incorporated in our vacuum tube sockets.

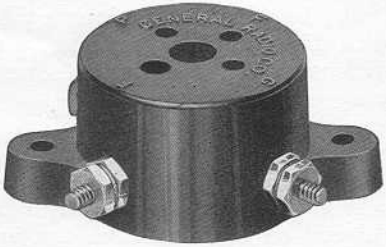


Type 156

Type 156 Socket

This socket is for the so-called standard American four-prong tubes. It fits such tubes as the UV-200, UV-201A, UV-202 and WD-12. The base is of heavy moulded bakelite providing adequate insulation. The springs are of bronze, nickel finished. They are so arranged as to make positive contact on the sides of the tube prongs. As a wiping, spring contact is made, a clean, positive connection is assured. The tube is of heavy brass with high polished nickel finish.

By loosening two screws and rotating the base this socket will fit the VT-2 tubes. Attention is called to the fact that not only will the socket fit the VT-2 tubes, but that the contact springs are heavy enough to carry, without arcing or heating, the heavy filament currents of these and other five-watt oscillator tubes.



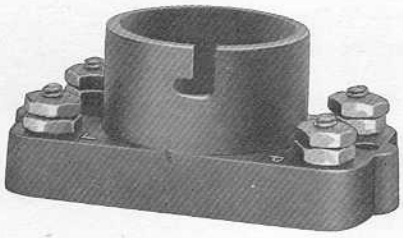
Type 282

Type 282 Socket

The WD-11 tubes will not fit the standard socket. The use of an adapter is inconvenient and expensive. A socket designed to fit

the tube is more satisfactory electrically and at the same time more economical.

The Type 282 socket is designed for use with the WD-11 tube. This socket is of moulded bakelite and is equipped with positive contact phosphor bronze springs. When the tube is inserted in the socket the springs make contact against the sides of the prongs and do not depend upon the downward pressure of the tube. The four connection terminals are plainly marked.



Type 299

Type 299 Socket

The UV-199 tube is similar to the WD-11 in that it requires a special socket. The current used in this tube is lower than that required by the other tubes. The prongs are shorter and the general dimensions smaller than on other tubes now available. These features have all been cared for in our Type 299 socket built for the UV-199 tube.

This socket is of moulded bakelite and has its terminals plainly marked. The springs are of phosphor bronze and are made rugged to insure good contact with the tube prongs.

The mounting holes of this socket are spaced the same as those of the 156 and 282 sockets. This feature makes it preferable to change the socket rather than to bother with an adapter when a permanent change in type of tube is desired.

Type 156 Socket $1.00
Dimensions 2½"x2½"x1¾". Weight 4 oz.
Code Word: "SOBER."

Type 282 Socket $0.60
Dimensions 2½"x1¾"x1". Weight 2 oz.
Code Word: "SOLID."

Type 299 Socket $0.60
Dimensions 2⅜"x1⅜"x1". Weight 2 oz.
Code Word: "STORY."

Type 231A
AMPLIFYING TRANSFORMER

The remarkable results obtained in long distance radio communication in recent years have been due largely to amplification made possible by the use of vacuum tubes. The simplest and most common type of amplification is that of the detected signals, and is commonly called audio frequency amplification.

In order to get the maximum of results with this type of amplification, the impedance of the grid circuit of the amplifier tube must be adjusted to the impedance of the previous detector or amplifier tube output circuit. This can best be accomplished by means of a suitably designed transformer. Our Type 231A transformer was built specifically to meet this situation. The primary receives the maximum amount of energy and delivers it undistorted in waveform and at the correct potential to the grid of the amplifying tube.

The core construction is such that there is little tendency for the setting up of external fields, with the resultant howling in the audio frequency circuit. The distributed capacity of the secondary is low, so that the maximum potential is obtained on the grid of the tube.

The primary has a direct current resistance of 1100 ohms, an alternating current resistance at 1000 cycles of 11,000 ohms, and a reactance at this frequency of 50,000 ohms. These figures for the secondary are 5500, 130,000, and 600,000 ohms respectively. These constants make the transformer particularly adapted to the UV-199, UV-201A, WD-11, WD-12 and tubes of similar impedance.

In order to obtain the best results from an amplifying transformer, certain precautions should be observed. Since what is wanted is the production of the maximum potential, or rather change of potential on the grid of the amplifying tube, it is best to connect the grid to the outside terminal of the secondary of the transformer. This is because the outer portion of the secondary has smaller capacity to

ground than the inner portion, due to the proximity of the latter to the primary winding, which is connected to the filament and other low potential parts of the circuit. This capacity effect increases with frequency and therefore reduces the intensity of high notes proportionately more than low ones, thus tending to cause distortion. Howling, or oscillation at audio frequencies, is caused by coupling (either electrostatic or magnetic) of the amplifier grid to some other part of the circuit, and is more troublesome with two or more stages of amplification than with one. If the electrostatic and magnetic couplings are made to oppose each other, the tendency to oscillate is minimized, and when a transformer is connected into a circuit it is worth while to reverse the leads to the primary to see which connection is better. In some cases, the oscillations are above audibility, but the strength of signals is reduced, nevertheless.

In an oscillating detector circuit the capacity of the telephone cords (which is of the order of 75 MMF.) is often sufficient to by-pass the radio frequency current around the high inductance of the phones, but when the primary of an amplifying transformer is substituted for the phones, it should be shunted with a condenser of a few hundred micromicrofarads or more.

Aside from its excellent electrical characteristics, this transformer is well designed mechanically. It is compact, and by means of the four projecting feet, each with a screw hole, may be mounted in any position. The core and coil are finished in black, while the brackets and binding posts are nickeled. Particular attention is called to the accessibility of both the binding posts and the mounting brackets.

Every transformer is guaranteed.

Type 231A Amplifying Transformer $5.00

Dimensions 2⅝"x2½"x2½". Weight 1 lb.

Code Word: "TUTOR."

Type 231M
MODULATION TRANSFORMER

This transformer is similar in general design to the Type 231A amplifying transformer, the only difference being in the winding. Its windings have been designed particularly for use with the Radiotron UV-202 five-watt transmitting tubes and other tubes of similar characteristics. To get the maximum modulation, the modulating device should have an impedance somewhat greater than the input impedance of the tube. This impedance is of the order of several hundred thousand ohms, while that of a telephone transmitter is but a few ohms. A modulation transformer serves to adapt the telephone transmitter impedance to that of the input circuit of the tube. The success of a radio telephone installation depends not only on the value of the antenna current, but also on how completely that current is modulated. Our Type 231M transformer has been designed to give the maximum modulation which is possible without distortion.

Type 231M Modulation Transformer $5.00

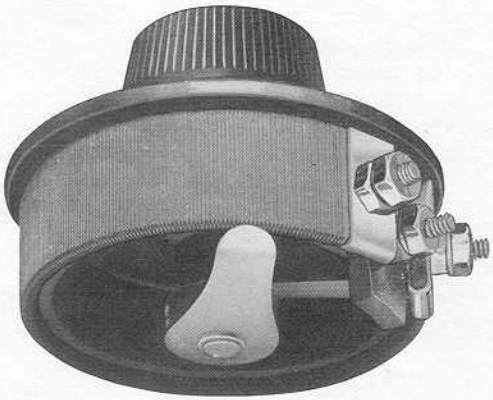
Dimensions 2⅝"x2½"x2½". Weight 1 lb.

Code Word: "TUNIC."

Types 214 and 301

RHEOSTATS AND POTENTIOMETERS

Rheostats used in vacuum tube circuits must be so constructed and the contact so arranged that there is no possibility of a momentary opening of the circuit, or a sudden change of resistance in the circuit. Either of these would result in an objectionable click in the telephone receivers. The resistance should also change uniformly throughout the entire range of the rheostat. This is necessary to secure the same degree of control for all working conditions of the battery. With the tubes now available, and with the gradual change of resistance provided by our Types 214 and 301 rheostats, no vernier attachments are necessary.



Type 214

The resistance units of both types of rheostats are tightly wound on specially treated fibre strips. Moulded bakelite, not an inferior substitute, is used for the base. The tapered moulded knob is provided with a pointer indicating the position of the contact arm. The shaft is ¼" in diameter and is arranged to fit panels up to ⅜" thick.

Where the best in rheostat construction is desired, and for laboratory use, the Type 214 is recommended. This rheostat is made in two types, 214A for back of panel mounting and 214B for front of panel or table use.

Although smaller in size, the Type 301 rheostat is similar in general construction to the Type 214. It is a practical rheostat for general use.

Many of the circuits now in common use require potentiometers to control the grid potential. Both the Types 214 and 301 are supplied with high resistance windings and a third connection to enable them to be used as potentiometers.

Type 214 Rheostat $2.25

Dimensions 3″d.x2¼″. Weight 7 oz.

Resistance	Current	CODE WORD Type 214A Back of Panel	Type 214B Front of Panel
2 ohms	2.5 amp.	RUDDY	RUMOR
7 ohms	1.5 amp.	RURAL	RUSTY
20 ohms	0.75 amp.	RAZOR	READY
50 ohms	0.5 amp.	RAPID	RAVEL

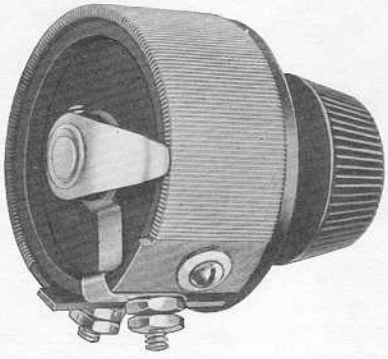
Type 214, 400 Ohm Potentiometer $3.00

Dimensions 3″d.x2¼″. Weight 7 oz.
Code Word, Type 214A, Back of Panel Mtg.: "ROSIN."
Code Word, Type 214B, Front of Panel Mtg.: "ROWEL."

Type 301 Rheostat $1.25

Dimensions 2″x1¾″x2⅛″. Weight 4 oz.

Resistance	Current	Code Word
10 ohms	1.0 amp.	REMIT
30 ohms	0.5 amp.	RENEW



Type 301

Type 301, 200 Ohm Potentiometer $1.25

Dimensions 2″x1¾″x2⅛″. Weight 4 oz.
Code Word: "REBUS."

In ordering be sure to specify resistance desired.

Type 127
HOT WIRE AMMETERS

The exacting requirements imposed on transmitting stations make is necessary that current measurements be made to insure operation at maximum efficiency. Since it is equally accurate on direct current or alternating current of any frequency a hot wire ammeter is the most convenient meter for this service. Not only may it be used for measuring radiation currents, but it may also be used to measure filament currents, storage battery charging rates, plate currents and for many other purposes. It is important that the meter should have low impedance, and it should be rugged and reliable. The Type 127 Hot Wire Ammeters are built to meet these requirements. During the recent war the U. S. Army and Navy used large numbers of these meters.

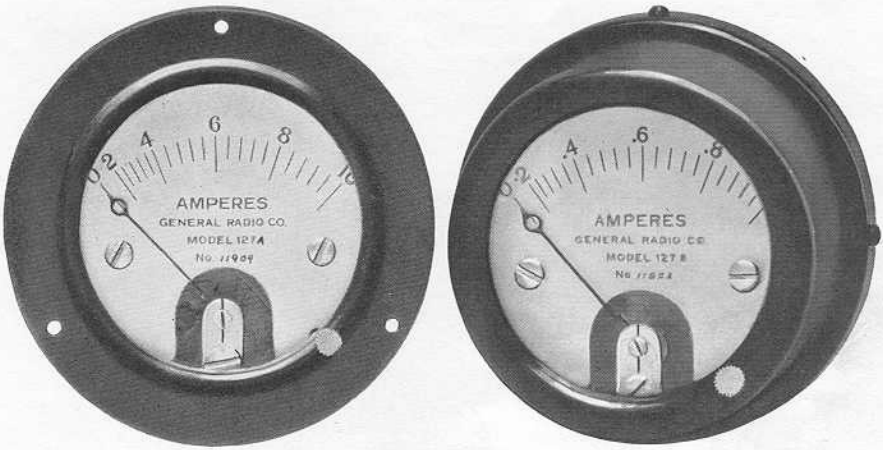
The expanding strip in these meters is of thin platinum, so as to prevent oxidation. It is so proportioned that it works at a low temperature and is of low resistance. These are two highly desirable features, since the former permits reasonable overloading without burning out, and the latter minimizes the losses.

The type of multiplying action is such that a more uniform scale is obtained than with many hot wire meters. These meters have been corrected for temperature so that there is very little shift of zero, and this is easily taken care of by the knurled adjusting screw.

These instruments are made in three types, the flush mounting for use on panels, the front-of-board mounting for use on switchboards,

and the portable type for general use. In mounting the flush type of meter an opening in the panel 2⅝ inches in diameter should be provided.

In mounting the front-of-board type allowance should be made for a case 3 inches in diameter. The flush type meters are mounted in metal cases finished in black japan, while the front-of-board and portable types have cases of moulded bakelite.



Type 127A

	Range	Code Word	Case	Price
100	Milli-Amps.	MEDAL	Flush Mounting	$9.00
250	Milli-Amps.	MERCY	Flush Mounting	7.75
500	Milli-Amps.	MERIT	Flush Mounting	7.75
1	Ampere	MERRY	Flush Mounting	7.75
1.5	Amperes	MINUS	Flush Mounting	7.75
2.5	Amperes	MINOR	Flush Mounting	7.75
5	Amperes	MINIM	Flush Mounting	7.75
10	Amperes	MINNY	Flush Mounting	7.75
	Galvanometer	MITER	Flush Mounting	7.25

Dimensions 3″d.x1½″. Weight 9½ oz.

Type 127B

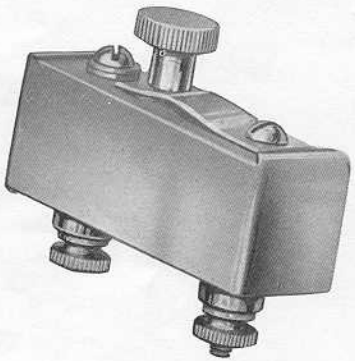
100	Milli-Amps.	MAYOR	Front of Board	$9.00
250	Milli-Amps.	MADAM	Front of Board	7.75
500	Milli-Amps.	MAJOR	Front of Board	7.75
1	Ampere	MANOR	Front of Board	7.75
1.5	Amperes	MISTY	Front of Board	7.75
2.5	Amperes	MAPLE	Front of Board	7.75
5	Amperes	MATIN	Front of Board	7.75
10	Amperes	MAXIM	Front of Board	7.75
	Galvanometer	MAGIC	Front of Board	7.25

Dimensions 3″d.x1½″. Weight 9 oz.

Type 127C

Range	Code Word	Case	Price
100 Milli-Amps.	MUGGY	Portable	$10.00
250 Milli-Amps	MOCHA	Portable	9.00
500 Milli-Amps.	MOGUL	Portable	9.00
2.5 Amperes	MOLAR	Portable	9.00
1 Ampere	MOTOR	Portable	9.00
5 Amperes	MUMMY	Portable	9.00
10 Amperes	MUSTY	Portable	9.00
Galvanometer	MOTTO	Portable	8.50

Dimensions 3"x4"x1½". Weight 10½ oz.



Type 178

HIGH FREQUENCY BUZZER

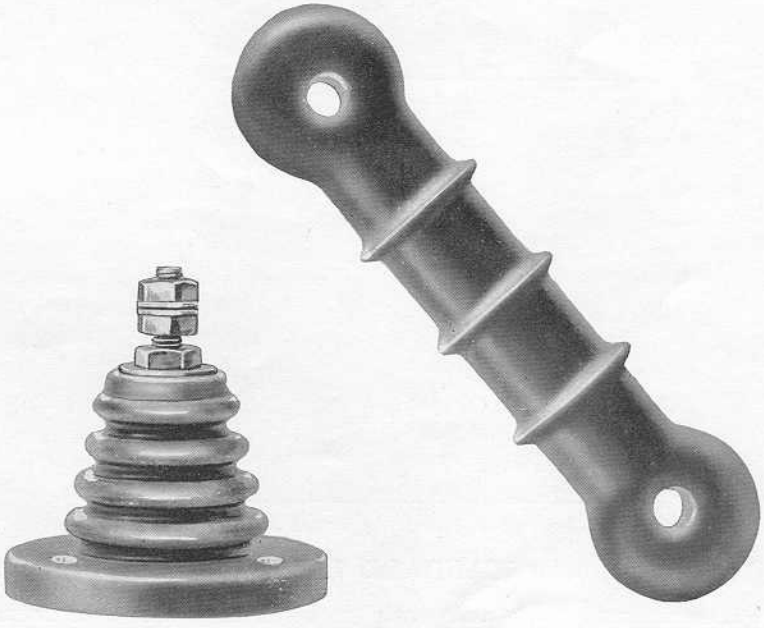
This buzzer has been designed for both laboratory and radio use. It combines pureness of tone, simplicity of adjustment and durability.

The frequency is approximately 800 cycles, but depends on the setting of the knurled adjusting screw. As the current required for the operation of the buzzer is approximately only 30 milli-amperes, it may be operated for long periods of time from small batteries. One dry cell will provide sufficient potential to operate this buzzer satisfactorily.

One of the noteworthy features of this buzzer is its freedom from sparking. This is important where pure tones are required. This feature makes the buzzer particularly adapted as a supply source for bridge measurements and for continuous wave telegraph modulation.

Type	Mounting	Code Word	Price
178A	Above Panel	BEFOG	$2.00
178B	Below Panel	BEGET	2.00

Dimensions 2"x1¾"x1". Weight 3 oz.



Type 260 *Type 280*

PORCELAIN INSULATORS

Porcelain, which has losses but one-tenth that of the usual moulded materials, is rapidly becoming the standard material for insulators.

For antenna insulation, correctly designed porcelain strain insulators are to be preferred to other commercial types. The Type 280 Strain Insulator, illustrated above, will be found particularly satisfactory. It is made of carefully glazed brown porcelain and will withstand severe weather conditions.

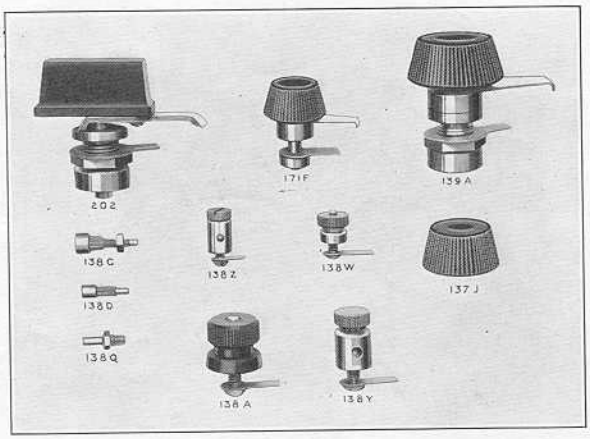
Type 280 Strain Insulator $0.25

Dimensions 4½"x1⅛"x1". Weight 4 oz.
Code Word: "CRULLER."

Another convenient insulator is the Type 260, illustrated above. It may be used inside to support wiring or instruments, or may be used outside for supporting lead-in or ground wires. Two of these insulators with a threaded rod connecting them make an excellent lead-in combination. As they are also constructed of glazed brown porcelain they may be used either indoors or out. Each insulator is equipped with nuts and washers assembled, as shown in the cut. Three polished nickel mounting screws are also provided.

Type 260 Insulator $0.25

Dimensions 2⅛"x2⅛"x2". Weight 4 oz.
Code Word: "CONIC."



STANDARD PARTS

Experimental work frequently requires that the experimenter build special pieces of apparatus in his own laboratory. When this apparatus is of a permanent or semi-permanent nature, it is desirable to have the binding posts, switches and other parts of the best quality, and to have them match instruments already installed. Consequently, we are now listing many of the standard parts used in the assembly of our own instruments.

BINDING POSTS

Type	Description	Diameter	Height	Screw Sizes	Price
138A	Insulated	3/4"	5/8"	10-32	$0.25
138W	N. P. Brass	7/16"	1/2"	6-32	0.12
138Y	" "	1/2"	3/4"	10-32	0.15
138Z	" "	3/8"	5/8"	6-32	0.10

SWITCHES AND PARTS

Type	Description	Price
139A	Multiple Leaf Switch 1 3/8" Radius	$0.95
171F	Single Leaf Switch 7/8" Radius	0.40
202	Low Contact Resistance Switch 1 3/8" Radius	1.25
138C	5/16" Contact for 139A or 202 Switches	0.05
138D	3/16" Contact for 171F Switch	0.04
138Q	Switch Stop with Nut	0.05

DIALS AND KNOBS

Type	Description	Price
137D	Moulded Knob (same as used on 139A Switch)	$0.30
137H	Moulded Knob (same as used on 246 Condenser)	0.75
137H	Knob and 4 inch Dial Mounted	1.50
137J	Moulded Knob (same as used on 301 Rheostat)	0.30
137K	Moulded Knob (same as used on 247 Vernier)	0.25

The types 137D and J Knobs are for ¼" shaft, while the 137H may be supplied for either ¼" or ⅜" shafts. The 137K Knob is tapped for a 10-32 thread.

The products of the General Radio Company include not only those listed in this bulletin, but also radio and electrical laboratory apparatus. Information and bulletins of special apparatus will be sent on request. These instruments include: Low Loss Variable Air Condensers, Precision Condenser, Vernier Condenser, Decade Condenser, Variometers, Standards of Inductance, Standards of Resistance, Decade Resistance Boxes, Impedance Bridge, Capacity Bridge, Slide Wire Bridge, Audibility Meter, Wavemeters, Ratio Arm Box, Galvanometer Shunt, Hot Wire Ammeters, Recorders, Amplifiers and Miscellaneous Apparatus.

All prices in this bulletin are strictly net, subject to change without notice, F. O. B. Cambridge, Mass. Cash should accompany orders from persons or firms with whom we have not already opened accounts. Unless otherwise instructed we shall use our own judgment regarding method of shipment.

This Bulletin replaces Bulletin 916

Standardize on General Radio Apparatus Throughout

GENERAL RADIO COMPANY

MANUFACTURERS OF

ELECTRICAL AND RADIO LABORATORY APPARATUS

CAMBRIDGE, MASSACHUSETTS

BULLETIN 918 **MAY 1924**

Type 271

MEDIUM FREQUENCY TRANSFORMER

DESCRIPTION

The amplification of wavelengths of the order of 10,000 meters (30 K.C.) requires a transformer of design materially different from that required for short wave radio frequency or audio frequency amplification. As it falls between the ranges of these two types the usual tendency is to make it a modification of one of them. A transformer designed by such a method could not attain the same degree of efficiency as one designed to meet definite requirements.

The Type 271 M.F. transformer has been designed to meet the specific requirements of a medium frequency transformer for use in long wave reception and in superheterodyne sets. It is shielded both electrostatically and electromagnetically, making it possible to use several of these transformers in cascade with a separation as small as one inch. This shielding also makes it possible to operate the amplifying tubes at their full capacity.

The working range is from 7,000 to 12,500 meters with a peak frequency of 10,000 meters. The turns ratio is 3.1:1. The core is of very thin silicon steel and of the shell type. It is so constructed as to give sufficient electromagnetic shielding and at the same time permits the use of only the small amount of steel that is required in a transformer of this type. The whole unit is enclosed in an attractively japanned metal case fitted with convenient terminal posts and mounting holes.

In Superheterodyne sets four of these transformers may be used with excellent results.

Type 271 Medium Frequency Transformer $5.00

Dimensions 2½" x 2¼" x 1½". Weight 6 oz.

Code Word "TULIP"

The products of the General Radio Company cover a complete line of radio and electrical laboratory apparatus. Information and bulletins of special apparatus will be sent on request. Our line includes the following: Variable Air Condensers, Vernier Condensers, Standard Condensers, Decade Condensers, Variometers, Standards of Inductance, Standards of Resistance, Decade Resistance Boxes, Wavemeters, Decade Bridge, Capacity Bridge, Slide Wire Bridge, Audibility Meters, Hot Wire Meters, Galvanometers, Thermo-Couples, Telephone Transformers, Miscellaneous Apparatus.

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Standardize on General Radio Apparatus Throughout