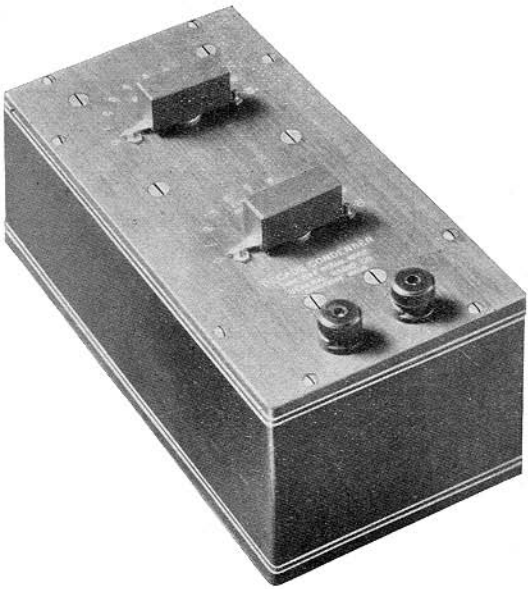
GENERAL RADIO COMPANY

MANUFACTURERS OF

ELECTRICAL AND RADIO LABORATORY APPARATUS

CAMBRIDGE, MASSACHUSETTS

BULLETIN 107 **NOVEMBER 1923**



Type 219F
DECADE CONDENSER

It is often as necessary to have an adjustable decade condenser for laboratory work as it is to have a decade resistance box. The utility of such a condenser is greatly reduced if it is necessary to open and close switches or to remove plugs to vary its capacitance. The condenser should have the same flexibility as a decade resistance box.

This feature of flexibility has been accomplished by the use of a sector switch, thus enabling the capacitance to be varied in the same easy manner as is done in our decade resistance units. The setting of the switch is definite, being determined by a ball and socket locking combination. The capacitance in microfarads is read directly opposite the end of the switch pointer.

In the 219F unit we have a two-dial combination giving a total capacitance of 1.1 microfarads. Each dial has ten steps, the lower dial of .01 microfarad each and the upper dial 0.1 microfarad each. This makes the range of the condenser from .01 microfarad to 1.1 microfarads adjustable in steps of .01 microfarad.

The condenser units are our specially wound, low-loss paper condensers adjusted with an accuracy of 2 per cent. Each condenser is separately mounted and is independent of the others of the unit. As these condensers are sealed in a hard-wood block, they cannot become loose or damaged. They will stand potentials of 300 volts. The complete unit is mounted in an attractive oak case with bakelite panel.

This condenser is particularly useful in filter or oscillating circuits. It is, in fact, an excellent all-around laboratory instrument.

Type 219F Decade Condenser $50.00

Dimensions 10″ x 5″ x 5¾″. Weight 6½ lbs.

Code Word " COVER."

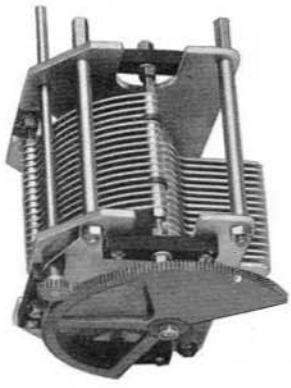
Type 239
VARIABLE AIR CONDENSER

The recent studies of dielectric losses have brought out forcibly the necessity for giving much attention to these losses in condenser design. Their importance has been further emphasized by the requirements of vacuum tube oscillating circuits. Such circuits demand for sharp resonance that these losses be kept a minimum. Condensers which might be adequate for crystal receiver circuits would be quite unsatisfactory for use in vacuum tube oscillating circuits.

Where great precision is required, there is available our Type 222 precision condenser. Because of its necessarily elaborate design, however, it is not suitable for installation in radio sets or for general laboratory use. It is a precision standard. In order to have available a condenser which would meet the general laboratory requirements and the rigid requirements of carefully designed radio sets, we have developed the rugged, low-loss condenser shown in the cut. This condenser is similar in general design to our precision condenser. It has metal end plates, locked cone bearings and is rigidly supported. The only solid dielectric material used is in the form of supporting strips for the fixed plates. These strips are of carefully selected hard rubber, and are

placed in a weak and uniform electrostatic field. This enables us to keep the losses at a minimum. The equivalent series resistance is but 12 ohms at a frequency of 1000 cycles and a capacitance of 1000 micro-microfarads. This is of the order of about a tenth of what is usually obtained in good variable air condensers. This very low loss enables oscillating circuits to be turned very sharply. This condenser will stand potentials up to 800 volts.

The rotary plates are grounded in order that capacity effects of the hand when adjusting the condenser may be reduced to a minimum. The plates are of heavy aluminum and are so shaped as to give a nearly uniform wavelength variation. This is particularly important when the condensers are to be used in wavemeters or radio receiving sets.



All types of this condenser are provided with a counterweight and when so desired, may be equipped with a slow-motion gear so that settings to a fraction of a division on the scale may be obtained with ease. This is a distinct advantage when tuning to continuous wave stations.

When mounted, the condenser is provided with oak case and engraved bakelite panel. All condensers, whether mounted or unmounted, are equipped with a three inch silvered dial divided into one hundred divisions.

Type 239E 1000 MMF. Mounted. Without gear.....$15.50
Dimensions 6″ x 6″ x 7″. Weight 4½ lbs.
Code Word " BABEL."

Type 239E 1000 MMF. Mounted. With gear.....$19.00
Dimensions 6″ x 6″ x 7″. Weight 4½ lbs.
Code Word " BANDY."

Type 239E 1000 MMF. Mounted. With gear. Calibrated $20.50
Dimensions 6″ x 6″ x 7″. Weight 4½ lbs.
Code Word " BANJO."

Type 239G 1000 MMF. Unmounted. Without gear.....$10.00
Dimensions 4½″ x 4¾″ x 6″. Weight 2 lbs.
Code Word " BARON."

Type 239G 1000 MMF. Unmounted. With gear.....$13.50
Dimensions 9½″ x 4¾″ x 6″. Weight 2 lbs.
Code Word " BASAL."

Type 239J 2000 MMF. Mounted. Without gear.....$18.50
Dimensions 6″ x 6″ x 9″. Weight 6 lbs.
Code Word " BASIN."

Type 239J 2000 MMF. Mounted. With gear.....$22.00
Dimensions 6″ x 6″ x 9″. Weight 6 lbs.
Code Word " BATTY."

Type 239J 2000 MMF. Mounted. With gear. Calibrated...$23.50
Dimensions 6″ x 6″ x 9″. Weight 6 lbs.
Code Word " BATON."

Type 239L 2000 MMF. Unmounted. Without gear.....$13.00
Dimensions 4½″ x 4¾″ x 6″. Weight 3 lbs.
Code Word " BAYAN."

Type 239L 2000 MMF. Unmounted. With gear.....$16.50
Dimensions 4½″ x 4¾″ x 6″. Weight 3 lbs.
Code Word " BEFIT."

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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 105]

Standardize on General Radio Apparatus Throughout.

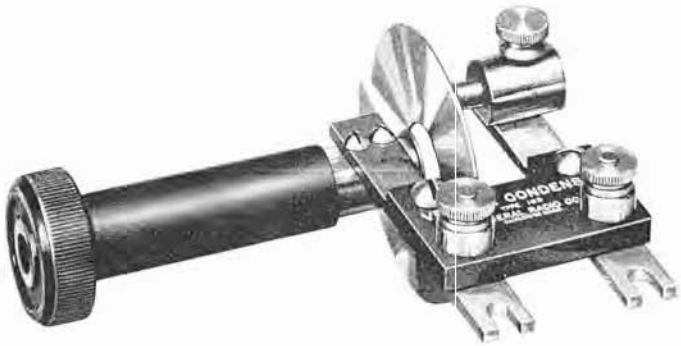
GENERAL RADIO COMPANY

MANUFACTURERS OF

ELECTRICAL AND RADIO LABORATORY APPARATUS

CAMBRIDGE, MASSACHUSETTS

BULLETIN 108 **NOVEMBER 1923**



Type 169
VERNIER CONDENSER

The increasing use of vacuum tube oscillating circuits where resonance is very sharply defined has created a demand for a variable condenser of small capacitance. Very often a movement of less than a single division on the ordinary variable air condenser will go beyond the resonance point. The Type 169 Vernier Condenser has been designed to go in parallel with the ordinary variable condenser so as to obtain a very fine adjustment. The spacing of the terminals is so arranged that this condenser may be slipped directly across the binding posts of any of our other condensers, thus permitting a parallel connection without using connecting wires.

The stationary plate may be varied in distance from the moving plate, thus permitting a variation in maximum capacitance from about .5 to 10 micromicrofarads. A hard rubber extension handle is provided to avoid effects from placing the hand too near the condenser.

This condenser is also useful in making measurements of very small capacitances, such as are possible with our Type 216 Capacity Bridge.

Type 169 Vernier Condenser $8.00

Dimensions 5½″ x 4¼″ x 2¾″. Weight ¾ lbs.

Code Word " CUBBY "

Type 246
VARIABLE AIR CONDENSER

The condenser shown above meets the need for a laboratory type of condenser less expensive than our Precision Condenser, Type 222, but possessing the same characteristics of permanency of calibration and low power loss, necessary in secondary standards of capacity. The permanency of calibration is assured by the heavy plates, the cone bearings whose adjustment is locked and by the general rugged construction. The low effective resistance is due to advanced engineering design, utilizing rotor plates grounded to the frame and stator plates supported by porcelain insulators. This type of construction is similar to that used in the practically resistanceless variable standards of capacity of the Bureau of Standards.

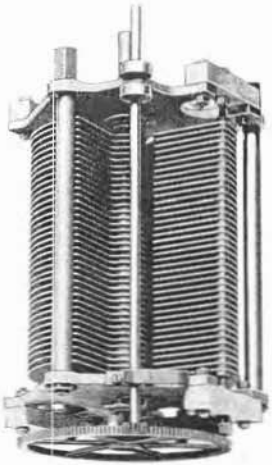
There is no change in capacity with frequency. The temperature coefficient is practically zero. The solid dielectric in this condenser is not only of small volume, and carefully selected, but is placed in a weak electrostatic field. Since this field does not vary with the position of the rotating plates, it may be assumed that the condenser is the equivalent of two parallel condensers, one being a perfect condenser of variable capacity, the other, a fixed condenser with which is associated all the power loss. This fact is very important when the condenser is used in measuring dielectric losses in connection with our Type 216 Capacity Bridge.

Accurate adjustment of capacity is made easy by the small knob which drives the main shaft through reduction gearing. There is no trouble due to variation of stray capacities by the operator's hand because the rotor plates are grounded to the frame. Laboratories find that this Type 246 Condenser satisfactorily meets the constantly arising demand, in ratio and general laboratory work, for a variable condenser of considerable capacity range, low power factor and permanent capacity. Some of its uses are given below.

USES. As a laboratory standard of capacity, in bridge measurements of condenser resistance, in any low resistance tuned circuit, in measuring the resistance of antennas, inductances and condensers at radio frequencies, and in any place where a high grade laboratory condenser can be used.

LOSSES. In all Type 246 Condensers at 1500 MMF. the power factor is about .005%; the resistance at 1000 cycles is about 12 ohms and at 300,000 cycles (1000 meters) the resistance is approximately .018 ohm.

CONSTRUCTION. The illustration shows the general construction. The plates are heavy aluminum, accurately spaced. The main shaft is fitted between cone bearings, so that there is practically no end-play. These bearings are worn in before their final adjustment. In the reduction gearing, mentioned above, a small fibroil pinion is pressed against the large gear by a phosphor bronze spring so that there is no backlash. Heavy cast aluminum end plates separated by large brass spacing pillars make a very rigid assembly.



CALIBRATION. The minimum and maximum capacity of each condenser is marked on the bottom of the case. The average capacities for each of the three sizes of this type of condenser follow:

Type	*Min. Cap.*	*Max. Cap.*	*Voltage (Peak)*
246L	55 MMF.	1500 MMF.	800
246M	70 MMF.	3000 MMF.	800
246P	72 MMF.	5000 MMF.	550

If desired, a celluloid protected calibration curve, accuracy .5%, is supplied at an extra charge of $1.00.

FINISH. The condenser is mounted in an attractive walnut case with engraved hard rubber panel. A four-inch silvered dial, divided into one hundred divisions, is securely fastened to the main shaft.

Type 246L Condenser, 1500 MMF. capacity.....$28.00
Dimensions 7½" x 7½" x 8¼". Weight 9 lbs.
Code Word "CEDAR"

Type 246M Condenser, 3000 MMF. capacity.....$34.00
Dimensions 7½" x 7½" x 11½". Weight 12 lbs.
Code Word "CHAOS"

Type 246P Condenser, 5000 MMF. capacity.....$38.00
Dimensions 7½" x 7½" x 11½". Weight 12½ lbs.
Code Word "CHARY"

Mounted Calibration curve, for any of above condensers.....$4.00

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(This Bulletin replaces Bulletin 106)

Standardize on General Radio Apparatus Throughout.

GENERAL RADIO COMPANY

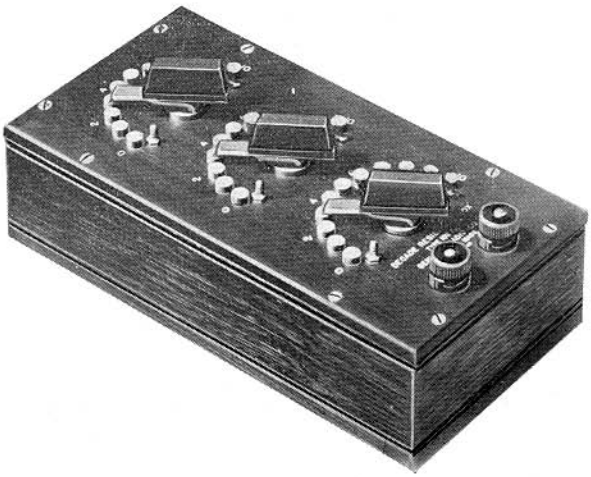
MANUFACTURERS OF

ELECTRICAL AND RADIO LABORATORY APPARATUS

CAMBRIDGE, MASSACHUSETTS

BULLETIN 207 **NOVEMBER 1923**

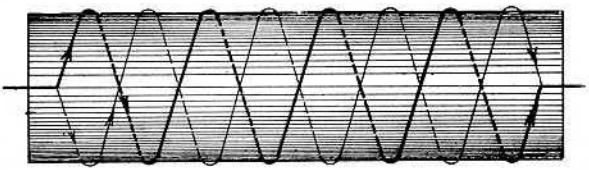
STANDARDS OF RESISTANCE AND DECADE RESISTANCE BOXES



The ideal standard of resistance for alternating current measurements, and particularly for those at radio frequencies, is one which has zero change of resistance with age, changes of temperature or frequency, and which has a zero phase angle for all frequencies. By selecting carefully the material on which the resistance coil is wound, the kind of wire used, and taking care that in soldering the terminals the connections are permanent and free from corrosion, there will be no appreciable change in resistance with age. As there are several alloys now available whose temperature co-efficient is very small and is constant over a wide range, it is a simple matter to determine with high accuracy the change of resistance of a coil for any ordinary work-

ing temperature. To obtain zero change of resistance with frequency and to obtain 100% power factor is a much more difficult proposition. A change in resistance with frequency is due largely to skin effect and to the distributed capacitance of the coil. The phase angle change with frequency depends only on the inductance and capacitance.

Several methods have been used to reduce the inductance and distributed capacitance of resistance units. The Ayrton-Perry method used in our coils is not only satisfactory electrically, but also mechanically. This method is illustrated by the diagram. The winding is placed on a thin bakelite form. A single wire is first wound on with



a space left between turns equal to the diameter of the wire. A second wire, connected so as to be in parallel with the first, is then wound on the form in the spaces between the turns of the first wire. The direction of rotation of the second winding is opposite from that of the first, thus making two crossings with the first wire in each complete turn. This arrangements keeps the currents in the two wires flowing in opposite directions and at the same time keeps adjacent wires at nearly equal potentials. This type of winding has the lowest distributed capacitance and inductance of any of the commercially used windings.

The current carrying capacity of the one-tenth ohm units is one ampere, that of the one ohm units one-quarter ampere, that of the ten ohm units one-tenth ampere, and that of the one hundred ohm and one thousand ohm units five-hundredths ampere. The accuracy of these coils above one ohm is .1% on direct current and about .5% at 1,500,000 cycles (200 meter wave length). The wire used has a practically nil temperature co-efficient of resistance and contains no iron. These resistance units are furnished in two styles of mountings, as single unit standards of resistance and as decade resistance boxes.

Type 102

DECADE RESISTANCE BOXES

For general laboratory use the most convenient resistance arrangement is that of decade units. By such a method it is possible to get nearly any value of resistance desired. Such units are compact and rugged. With the use of multiple-leaf contact brushes with each leaf making independent contact, and with the ends of these brushes so cut that they are not tangent to the path of travel, thereby preventing the cutting of grooves in the contact studs, the dial method of mount-

ing decade resistance units is fast replacing the older and less satisfactory plug method of connection. This newer method eliminates the inconvenience of the shifting of plugs, and also their possible loss.

The General Radio Co. Type 102 decade units are mounted on bakelite panels with engraved lettering, and are enclosed in oak boxes. The exposed metal parts are finished in polished nickel.

Attention is called to the fact that each decade dial has eleven contact studs, a zero and ten steps. This feature is especially important when working at the upper or lower ends of a dial.

These decade boxes are made in three general types, two, three and four dials. These general types, however, may cover different ranges. The complete lists of these decade boxes is as follows:

Type	*Units*	*Code Word*	*Price*
102D	10 one-tenth ohm coils 10 one ohm coils	DECOY	$24.00
102E	10 one ohm coils 10 ten ohm coils	DECRY	25.00
102H	10 ten ohm coils 10 one hundred ohm coils	DIVAN	28.00
102F	10 one-tenth ohm coils 10 one ohm coils 10 ten ohm coils	DELTA	32.00
102G	10 one ohm coils 10 ten ohm coils 10 one hundred ohm coils	DIGIT	35.00
102K	10 one-tenth ohm coils 10 one ohm coils 10 ten ohm coils 10 one hundred ohm coils	DEFER	47.00
102J	10 one ohm coils 10 ten ohm coils 10 one hundred ohm coils 10 one thousand ohm coils	DEBIT	53.00

The above Decade Resistance Boxes have the following weights and dimensions:

Number of Dials	*Dimensions*	*Weight*
2	7⅜″ x 5″ x 4¼″	2½ lbs.
3	10″ x 5″ x 4¼″	4 lbs.
4	12⅝″ x 5¼″ x 5½″	5 lbs.

Type 133
STANDARDS OF RESISTANCE

These resistance units are single coils, wound by the method described above, and fitted with a suitable mounting. The case is of brass with black crystalline finish. The panel is of bakelite with engraved lettering. The accuracy of adjustment is 0.1%. These standards are made in the following seven convenient sizes:

Type	*Resistance*	*Code Word*	*Price*
133A	1 ohm	Recur	$7.00
133B	5 ohms	Refer	7.00
133C	10 ohms	Regal	7.00
133D	50 ohms	Relax	7.00
133E	100 ohms	Relic	7.00
133F	500 ohms	Repay	8.00
133G	1000 ohms	Repel	8.00

Dimensions 3″ d. x 2¼″. Weight 11 oz.

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[This Bulletin replaces Bulletin 205]

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GENERAL RADIO COMPANY

MANUFACTURERS OF

ELECTRICAL AND RADIO LABORATORY APPARATUS

CAMBRIDGE 39, MASSACHUSETTS

BULLETIN 208 **NOVEMBER 1923**

Type 210
RATIO ARM BOX

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 207. 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."

Type 229
UNIVERSAL GALVANOMETER SHUNT

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."

Type 125
PHANTOM ANTENNA RESISTOR

For many tests of transmitting apparatus, it is desirable to replace the antenna by a local circuit, the constants of which are more easily and accurately determined. It also prevents interfering with neighboring stations. The Type 125 Phantom Antenna Resistor is provided for this purpose.

These units are wound on asbestos-board forms, mounted vertically, an arrangement which insures a good circulation of air. The resistance material is in the form of a ribbon, and has a very low temperature co-efficient of resistance and a constant resistance up to very high frequencies. The inductance is very low and the resistance is accurately adjusted to the stated values.

The resistor is made in two sizes. Type 125A of 4 units of 4 ohms each, and Type 125G of 2 units of 2 ohms each. The separate units of Type 125A have a carrying capacity of 5 amperes and those of Type 125G 15 amperes. It is possible to connect these units so as to obtain the following combinations of resistance and carrying capacity:

Type 125A		Type 125G	
Resistance	Carrying Capacity	Resistance	Carrying Capacity
2 ohms	10 amperes	1 ohms	30 amperes
4 "	5 "	2 "	15 "
8 "	5 "	4 "	15 "
12 "	5 "		
16 "	5 "		

Type 125A Phantom Antenna Resistor..... $15.00

Dimensions 7¾" x 6" x 4¼". Weight 3¼ lbs.

Code Word " RAVEN."

Type 125G Phantom Antenna Resistor..... $32.00

Dimensions 10¾" x 7⅝" x 5½". Weight 7 lbs.

Code Word " REBEL."

Type 130
SLIDE WIRE BRIDGE

The design of this bridge is such as to permit of obtaining all the ordinary measurements made with a bridge and at the same time does not make the instrument bulky or heavy. The bridge is particularly adapted for class-room demonstration or student use where a variety of arrangements such as the Wheatstone, Kelvin, or Carey Foster circuits are required. Great care has been used in the construction of this bridge. The base is of polished oak with engraved box-wood scale. The slider moves on a brass tube one-half inch in diameter, insuring good contact and durability. The slide wire is of manganin, one-half meter long, and has a resistance of approximately 0.9 ohm. Two pairs of binding posts are provided for extension coils to increase the range of the slide wire. Heavy copper connecting bars are used throughout. The metal parts are finished in dull nickel.

Type 130 Slide Wire Bridge. $18.00

Dimensions 24″ x 4½″ x 2″. Weight 3¾ lbs.

Code Word "SATYR."

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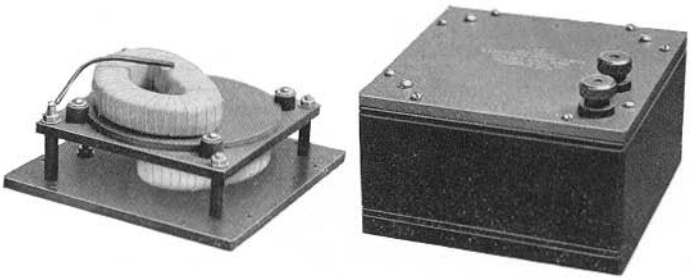
ELECTRICAL AND RADIO LABORATORY APPARATUS

CAMBRIDGE, MASSACHUSETTS

BULLETIN 305 **NOVEMBER 1923**



Type 106

STANDARDS OF INDUCTANCE

These standards of inductance have been designed for general laboratory use and are suitable for radio frequencies as well as for commercial or audio frequencies. To minimize skin effects and eddy current losses the windings are of stranded wire with the separate strands insulated from each other. There is no metal in the field of the coils, in fact only a very small amount of metal, which is all non-magnetic, is used in the entire assembly of this instrument.

Considerable errors, particularly in bridge measurements, may be introduced if the inductance standards have a large outside field. To minimize this effect these standards are wound astatically, thus making the external field negligible. The use of the astatic winding eliminates the effects of other inductances in the vicinity of the standard.

The coils are form wound, firmly bound, and securely fastened to bakelite plates. As the final adjustment is accomplished by rotating one of the coils, it is possible to adjust these standards accurately to their specified values. The accuracy of this adjustment is one-tenth of one per cent. The current carrying capacity of the 1 millihenry and smaller size coils is 2 amperes, that of the 5 and 10 millihenry sizes 1 ampere, and that of the 100 millihenry coil ½ ampere.

Type	*Inductance*		*Code Word*	*Price*
102L	.10	Millihenry	INNER	$24.00
106G	1.0	Millihenry	INERT	24.00
102J	10.0	Millihenrys	IRATE	24.00
102K	100.0	Millihenrys	ISLET	24.00

Dimensions 6″ x 6″ x 4″. Weight 2¾ lbs.

Type 107
VARIOMETER

For general laboratory work a properly designed variometer has a great variety of uses. In addition to serving as a variable standard of self or mutual inductance, these instruments have many uses such as in filter circuits, radio frequency oscillating circuits and similar work.

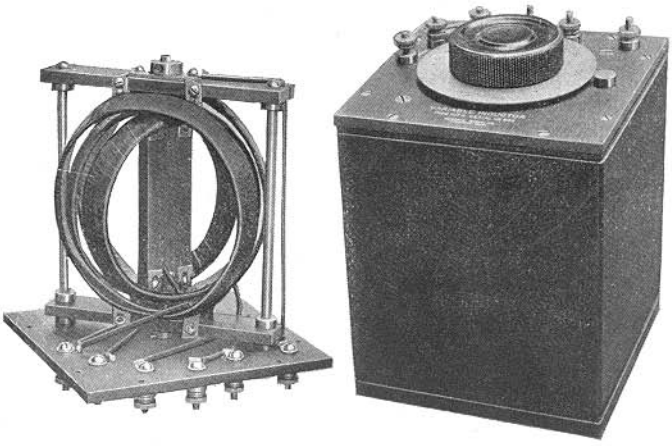
The Type 107 Variometer consists of two coils which are both sections of cylinders one of which is slightly smaller than the other. The smaller coil is mounted within the larger in such a manner that it may be rotated about its vertical diameter. The connections of each coil are brought out separately in order that the coils may be connected in series, parallel, or used separately. This arrangement not only increases the range through which the inductance may be varied, but also increases the usefulness of the instrument.

A silvered etched dial with black filled lines and figures indicates the relative position of the coils. When the dial reading is zero, the currents in the two coils are circulating in opposite directions and the inductance is a minimum. When the dial reading is 50, corresponding to a rotation of 90°, the coils are at right angles and the total inductance is the sum of the self-inductances of the two coils for the series connection, and approximately one-half the inductance of a single coil for the parallel connection. At the 100 reading the currents in the coils are flowing in the same direction and the total inductance becomes the sum of the self-inductances of the coils plus twice their mutual inductance for the series connection, and for the parallel connection approximately one-half of the sum of the mutual inductance and the self-inductance of a single coil.

The connections to the moving coil are made through multiple contacts, giving a low and constant resistance. The coil windings of the smaller inductance sizes are of stranded wire with the separate strands insulated from each other. The field of these coils contains but very little solid dielectric and little metal. This metal is non-magnetic and so placed as to be in a very weak field.

The entire instrument is mounted in an oak case with engraved bakelite panel. The metal parts are finished in polished nickel.

Attached to the bottom of each variometer case is a certificate giving the maximum and minimum inductance when the coils are connected in series. Calibration curves may also be supplied, for an additional charge of $5.00, giving the inductance throughout the entire range for both the series and parallel connections.



Type 107F About .02 to .4 M. H. $24.00

Carries 3 amperes continuously.

Code Word " HAPPY "

Type 107G About .10 to 4 M. H. $24.00

Carries ¾ ampere continuously.

Code Word " HARDY "

Type 107H About .4 to 18 M. H. $24.00

Carries ½ ampere continuously.

Code Word " HAVEN "

Dimensions 6″ x 6″ x 8″. Weight 4¾ lbs.

We are also prepared to build special inductance coils to specification. Coils for filter circuits and calibrated oscillating circuits a specialty.

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 Meter, 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 304**)

Standardize on General Radio Apparatus Throughout.

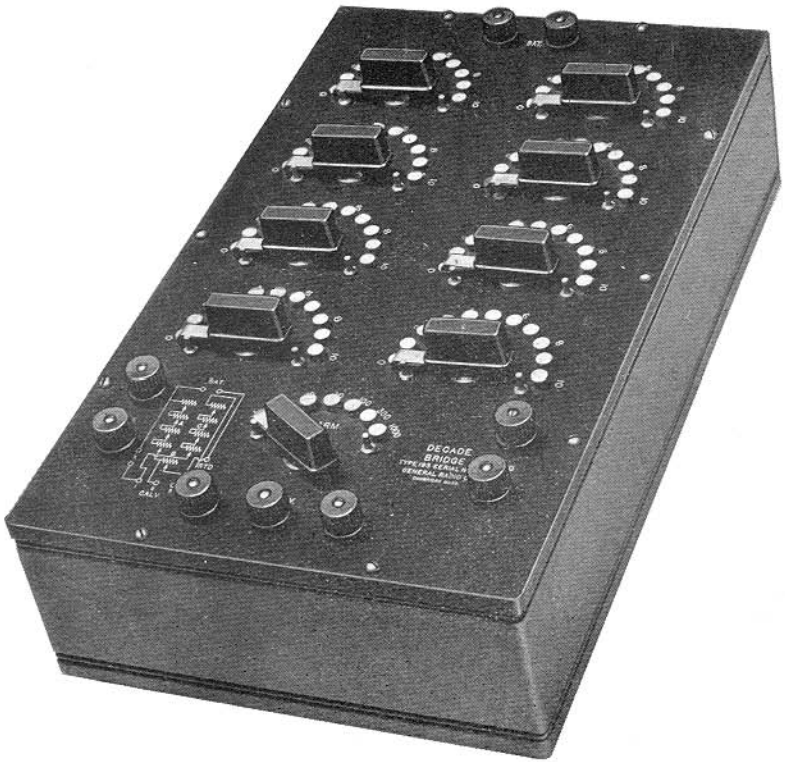
GENERAL RADIO COMPANY

MANUFACTURERS OF

ELECTRICAL AND RADIO LABORATORY APPARATUS

CAMBRIDGE, MASSACHUSETTS

BULLETIN 407 **NOVEMBER 1923**



Type 193

DECADE BRIDGE

The Type 193 Decade Bridge is designed to cover the many uses which are required of a laboratory bridge. It is adapted for both direct and alternating current measurements. While it is sufficiently flexible to give the necessary variety of connections demanded in the laboratory, when set up for commercial testing its operation becomes so simple that very little instruction is required by unskilled operators to make routine measurements.

The general arrangement of this bridge consists of three resistance arms, two of which are four dial decades each having a range of from 0.1 ohm to 1111 ohms. The third arm is a single dial having

resistance combinations of 1-3-10-30-100-300 and 1000 ohms. In order to adapt this bridge for use with frequencies up to 10,000 cycles all resistance units are wound non-inductively and have very low distributed capacitance. This is accomplished by using the Ayrton-Perry Method of winding described in our Bulletin No. 207.

The accuracy of adjustment of these coils is 0.1% on direct current and about 0.5% at 1,500,000 cycles. The wire used has a practically nil temperature co-efficient of resistance and contains no iron. The current carrying capacity of the one-tenth ohm units is one ampere, that of the one ohm units one-quarter ampere, that of the ten ohm units one-tenth ampere, and that of the one hundred ohm units five-hundredths ampere.

Dial switches are used in place of the older and less satisfactory plug method of connection. This eliminates the inconvenience of the shifting of plugs, and also their possible loss. These switches have multiple-leaf contact brushes with each leaf making independent contact. The ends of the contact leaves are so cut that they are not tangent to the path of travel, thereby preventing the cutting of grooves in the contact studs. These switches have a low and constant resistance, even after long use. Attention is called to the fact that each decade dial has eleven contact studs, a zero and ten steps. This feature is especially important when working at the upper or lower ends of a dial

The cabinet is of polished walnut, fitted with a copper lining to shield the resistance units from outside electrostatic fields. The panel is of polished hard rubber with engraved lettering. A complete wiring diagram is also engraved directly on the panel. The metal parts are finished in bright nickel. Insulated binding posts are used throughout. A tight fitting wooden dust cover is furnished with each bridge to protect the panel and switches when not in use.

Operation

The three general classes of measurements to which this bridge is adapted are direct current resistance by the Wheatstone method, inductance, and capacitance. For inductance and capacitance measurements an external standard is employed, while for resistance measurements one of the bridge arms is used as a standard. The circuits of the bridge are shown in the diagram.

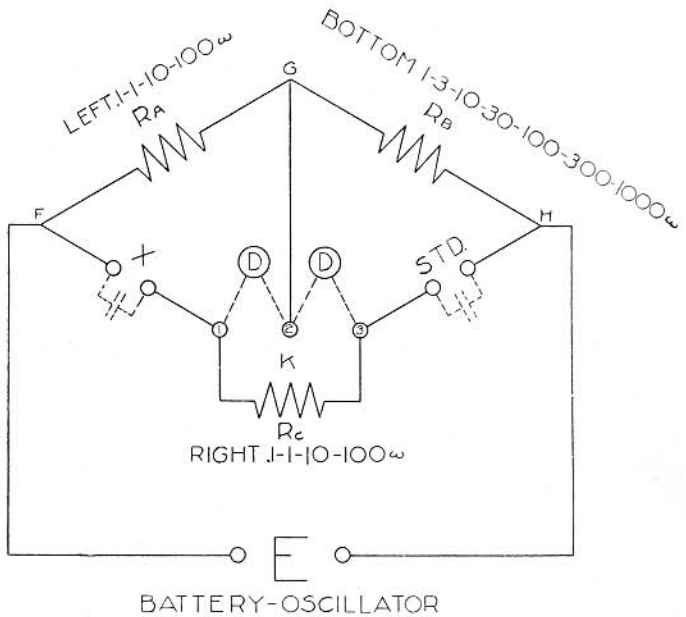
The power source supplied to the bridge is connected to the binding posts marked BAT. For direct current resistance measurements this source is one or two cells of a battery, while for capacitance and inductance measurements an alternating current source must be used. The alternating current should be of known and constant frequency and free from harmonics. The General Radio Co. Type 213 Audio Oscillator was designed for this work.

For direct current resistance measurements a sensitive galvanometer should be used to indicate the balance point. This galvanometer is connected between the GALV binding posts 1 and 2. When an alternating current source is supplied to the bridge in capacitance and inductance measurements, a sensitive telephone receiver or vibration galvanometer is used to detect the balance point. This detector will be connected to either the GALV binding posts 1 and 2, or 2 and 3 depending on the conditions of balance.

To make a direct current resistance measurement by the Wheatstone method the resistance to be measured is connected to the binding posts marked X. A short circuit bar is placed between the STD binding posts. Arms A and B are used as ratio arms and Arm C adjusted to obtain a balance. The unknown resistance is then given by the expression

$$R_X = \frac{R_A}{R_B} . R_C$$

For inductance and capacitance measurements the bridge is used as an impedance bridge, that is, the bridge is simultaneously balanced for resistance and reactance. The inductance or capacitance to be measured is connected at X and the inductance or capacitance standard at STD. In this case Arms A and B are used as ratio arms and Arm C is a compensating resistance in order that the bridge may be in balance



for resistance as well as for reactance. When the telephones, or vibration galvanometer, are connected between GALV binding posts 1 and 2, this compensating resistance is in series with the standard, and when the telephones are connected to binding posts 2 and 3 this compensating resistance is in series with the unknown impedance. The compensating resistance should be connected so as to be in series with the impedance having the lower resistance. At the balance point the following relationships exist between the unknown and the standard impedance.

Inductance measurements $L_X = \frac{R_A}{R_B} . L_S$

Capacitance measurements $C_X = \frac{R_B}{R_A} . C_S$

Uses

The Type 193 Decade Bridge is designed for general laboratory use. For direct current measurements its principal use is as a Wheatstone bridge. The connections are such, however, that the different arms may be used independently as standard decade resistance units. When used as an impedance bridge the range for capacitance measurements is from 0.003 to several microfarads, and for inductance measurements from about 20 microhenrys to several henrys. When making measurements of small capacitances or large inductances the sensitivity of the bridge may be increased by using in the detector circuit a telephone transformer, such as the General Radio Co. Type 166. The high impedance side, which is marked SEC, is connected across the proper GALV binding posts and the telephone receivers connected across the low impedance side. Since all of the resistance units are wound non-inductively and to have very low distributed capacitance they are adapted for use at radio frequencies.

Since the bridge is so arranged that the individual arms are accessible, use may be made of the principle that in diagonal arms a capacitance will balance an inductance. By the correct choice of the inductance or capacitance standard, the bridge may be made direct reading in either capacitance or inductance. The precision of such measurements is that of the adjustment of the bridge, namely 0.1%.

Type 193 Decade Bridge $125.00
Size 17″ x 10½″ x 5″. Weight 12¾ lbs.
Code Word " BIGOT."

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

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

Western Electric Receivers (Type 1002C) $12.00

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[This Bulletin Replaces Bulletin 405]

Standardize on General Radio Apparatus Throughout.

GENERAL RADIO COMPANY

MANUFACTURERS OF

ELECTRICAL AND RADIO LABORATORY APPARATUS

CAMBRIDGE, MASSACHUSETTS

BULLETIN 408 NOVEMBER 1923

Type 216
CAPACITY BRIDGE

Description

There has long been a need for some simple yet reliable method of measuring capacitances as low as a few micromicrofarads with a precision of at least one-tenth of one percent. The desirability of a convenient, reliable, and accurate method of comparing the losses in small samples of dielectrics has also long been recognized. It was to meet these needs that the General Radio Co. Type 216 Capacity Bridge was designed.

Reduced to its simplest form, this bridge consists of a Wheatstone Bridge circuit with resistances in the ratio arms and capacitances in the unknown and standard arms. The complete arrangement is shown by the diagram on Page 433.

The input source E is the General Radio Co. Type 213 1000-cycle Audio Oscillator, described in Bulletin 712. This oscillator is connected to the input terminals "AC" of the bridge. These terminals lead to a shielded compartment containing an input transformer whose primary is grounded at its mid-point. The primary and secondary windings of this transformer are shielded from each other.

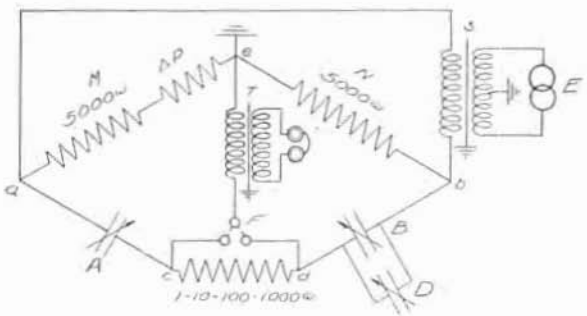
The bridge circuit consists of the two ratio arms M and N, and the arms A and B in which the standard and the unknown condensers are placed. The junction point of the two ratio arms is grounded.

These ratio arms are made up of equal resistance units wound on thin cards to reduce the inductance and the distributed capacitance. A method, however, is provided for adding resistance units to either the M or N arm in order to get small amounts of unbalancing. A four dial decade resistance box, the units of which are Ayrton-Perry non-inductive low distributed capacitance coils, is arranged so that it may be connected in either the A or B arm by means of the switch F. A sensitive telephone receiver, or a vibration galvanometer, is used to detect the point of balance. This detector is connected to the bridge through a transformer which has a grounded shield between the primary and secondary windings.

The cabinet containing the bridge units is of polished walnut. All panels are of polished hard rubber with engraved lettering. The metal parts are finished in bright nickel. The interior of the cabinet is lined with copper, lacquered to retain its polished finish. The wiring, as well as the separate units of the bridge, is thoroughly shielded. Complete instructions accompany each bridge.

Operation

Since it is desired to detect minute changes in resistance and capacitance with this bridge it is very essential that each unit of the bridge be constructed to give a resultant maximum sensitivity. It is also very important that the supply source be of constant frequency and



free from harmonics. Reliable readings for very small changes of capacitance cannot be obtained unless the supply source has a pure tone. It is for this reason that the Type No. 213 Audio Oscillator is recommended for use with this bridge.

The use of a supply transformer, instead of connecting the audio oscillator directly across the ratio arms, aids in the proper operation of the bridge. A shield, placed between the primary and secondary winding of this input transformer, prevents errors which would be caused by capacitance to earth of the supply source. In order that the potentials impressed across each of the ratio arms of the bridge shall be equal, the junction point of these arms and also the mid-point of

the input transformer primary is grounded. The use of an input transformer increases the voltage applied to the bridge arms, a very desirable feature in the measurement of small capacitances.

Since the impedance of small capacitances at 1000 cycles is high — that of 1000 micromicrofarads being 160,000 ohms — it is desirable that a high impedance detector be used to denote the balance point of the bridge. As the impedance at 1000 cycles of a pair of sensitive telephone receivers is only of the order of 20,000 ohms, it is evident that this is too low. For this reason a telephone transformer with a primary impedance of 200,000 ohms and a secondary impedance of 20,000 ohms is used. This arrangement provides the correct impedance in both the bridge and the telephone circuits and makes it possible to detect a very small difference in potential, such as that caused by the unbalancing of the condenser arms to the extent of one hundredth of a micromicrofarad. A shield similar to that of the input transformer is placed between the primary and secondary windings to prevent the introduction of errors caused by outside capacitances to earth.

As the bridge is designed primarily for the comparison of equal capacitances, the ratio arms are made equal. A variable standard low loss condenser such as the General Radio Co. Type 222 precision condenser is particularly adapted for use in the standard arm of the bridge. The use of equal ratio arms without any switches makes it possible to adjust these arms very accurately, and insures that their resistance will always be constant. Since these ratio arms are exactly alike, any change in inductance or capacitance with frequency will be the same in each arm, and will have no resultant effect on the balance of the bridge.

It is very often desirable to calibrate a vernier condenser whose total capacitance is of the order of three or four micromicrofarads. For this work the bridge is first balanced, using capacitances of the order of 1000 micromicrofarads. If one of the resistance ratio arms were to be increased one part in one thousand, i.e. from 5000 to 5005 ohms, the ratio of the capacitances would be changed accordingly, which is a change of one micromicrofarad. In order that the ratio arms may be changed in this manner, resistance units are supplied with the bridge. These units may be added to either ratio arm. Although the standard equipment of each bridge includes three of these resistance units so as to give ratios of unbalancing of .001, .01 and .1, they can be furnished to give any ratio desired.

In order to obtain a balance with a bridge of this type, the resistance as well as the reactance must be balanced. To provide this resistance balance a four dial decade resistance unit may be placed in either the A or B arm. The shift is made by means of a single switch located on the side of the cabinet. The use of this decade resistance provides a convenient and accurate means of measuring dielectric losses.

A set of operating instructions covering in detail its uses and operation is supplied with each bridge.

Uses

The Type 216 Capacity Bridge is an instrument by means of which capacitances up to several microfarads can be measured quickly and accurately. It provides also a means of measuring capacitances as small as a few micromicrofarads to a precision of one hundredth of a micromicrofarad. Since the dielectric loss equivalent resistance at 1000 cycles can be measured to an ohm with this bridge, it is possible to obtain the phase angle of condensers or to compare different dielectrics. The testing of small samples of cable or the study of temperature changes in dielectrics is made easy because of the sensitivity of this instrument. An example of this latter use is a test made on a sample of hard rubber. The sample which was 3 inches square and one-half inch thick was placed between two metal plates. At 54° F. this sample had a capacitance of 11.20 micromicrofarads and a phase angle of 48′. When heated to 100° F. the capacitance had increased to 12.25 micromicrofarads and the phase angle to 1° 55′.

Type 216 Capacity Bridge $160.00
Dimensions 15″ x 14″ x 7″. Weight 17 lbs.
Code Word "CIVIC"

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

Type 222 Precision Condenser. Max. Cap. 1500 MMF. $90.00
Dimensions 9″ x 8½″ x 10″. Weight 15 lbs.
Code Word "COPAL"

Type 246L Balancing Condenser. Max. Cap. 1500 MMF. $28.00
Dimensions 7½″ x 7½″ x 8¼″. Weight 9 lbs.
Code Word "CEDAR"

Type 169 Vernier Condenser $8.00
Dimensions 5½″ x 4¾″ x 2¾″. Weight ¾ lbs.
Code Word "CUBBY"

Type 1002C Western Electric Double Head Receivers $12.00

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[This Bulletin replaces Bulletin 406]

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GENERAL RADIO COMPANY

MANUFACTURERS OF

ELECTRICAL AND RADIO LABORATORY APPARATUS

CAMBRIDGE, MASSACHUSETTS

BULLETIN 504 **NOVEMBER 1923**

Type 170
HOT WIRE METER

An instrument for the measurement of currents at high frequencies must have its inductance and capacitance kept as small as possible. High impedance would cause the readings to vary with frequency. For many radio frequency measurements a suitably designed hot wire ammeter has the necessary characteristics which particularly adapt it to this work. It should, however, be recognized that a hot wire ammeter is inherently a less accurate instrument than those of the moving coil type, which of course are impractical for measuring current at high frequencies. In our types 127 and 170 Hot Wire Ammeters careful design and good workmanship have produced an instrument which is electrically and mechanically good, rugged and reliable. These meters, particularly the galvanometer type, which is the 250 milliampere size uncalibrated, are used very extensively in wavemeters

and similar oscillating circuits for determining the resonance point. The Type 127 meters are used extensively for measuring the radiation, filament and plate currents in experimental continuous wave transmitting stations. The Type 170 meters have found a wide use outside of the radio field. They are used as transfer instruments in generator testing and similar work.

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. This type of instrument is equally accurate on direct or alternating current of any frequency.

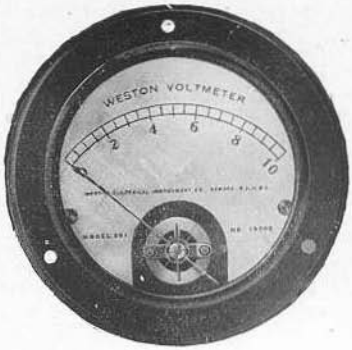
These instruments are made in two general sizes. Type 127 is the smaller, or three-inch size, and is made in three types, portable, front-of-board mounting and flush mounting. Type 170 is the large size and is made only in the portable type. It is mounted in a polished, walnut case and fitted with carrying strap.

The Type 170 meters are made in the sizes listed below. The Type 127 meters are illustrated and listed in Bulletin 916.

TYPE 170

Range	*Code Word*	*Case*	*Price*
100 M. A.	EXULT	Portable	$24.00
250 M. A.	EVOKE	Portable	22.00
500 M. A.	EXACT	Portable	22.00
1 amp.	EXCEL	Portable	22.00
2 amp.	EXERT	Portable	22.00
3 amp.	EXILE	Portable	22.00
5 amp.	EXIST	Portable	22.00
10 amp.	EXPEL	Portable	22.00
20 amp.	EXTRA	Portable	22.00
Galvanometer	ETHER	Portable	21.00

Dimensions 4¾″ x 5″ x 3½″. Weight 16 oz.



WESTON METERS

Supplementing our own line of hot wire ammeters, we can supply Weston direct-current volt meters, direct-current ammeters and thermo-ammeters. These meters are all the 3″ size, flush mounting with black japan finish. They are similar in appearance and interchangeable with our Type 127-A hot wire ammeters. The quality and standards of Weston meters are so high and so well known that it is unnecessary to describe them in further detail.

Model 301
DIRECT-CURRENT VOLTMETERS

These meters are made for two general classes of service — low range, for determining the filament potential of vacuum tubes, and high range, for determining plate potentials. The most popular sizes are:

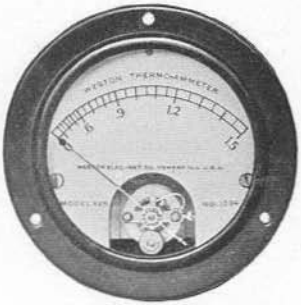
Range	*Code Word*	*Price*
10 volts	Autobath	$8.00
15 volts	Autobasket	8.00
50 volts	Autobattle	8.00
100 volts	Autobat	13.00

Higher ranges using external shunts may be supplied, if desired.

Model 301
DIRECT-CURRENT AMMETERS

Plate and filament current measurements are as necessary as the corresponding voltage measurements. For this service the Model 301 direct-current ammeters are to be recommended. The most useful ranges are:

Range	*Code Word*	Price
5 milliamperes	Autogale	$10.00
100 milliamperes	Autogage	8.00
200 milliamperes	Autogasket	8.00
1.5 amperes	Autocab	8.00
3 amperes	Autocoffer	8.00
5 amperes	Autocomb	8.00
10 amperes	Autocouple	8.00



Model 425
THERMO-AMMETERS

Where quickness in movement and low meter energy consumption are important features, we recommend the use of thermo-ammeters in place of hot wire ammeters for measuring antenna currents. The Weston Model 425 thermo-ammeter has the same overall dimensions as the Model 301 direct-current meters. This unity in size and appearance greatly adds to the attractiveness of a completely equipped control panel. The Model 425 meters are made in the following sizes:

Range	*Code Word*	*Price*
1.5 amperes	Thiazin	$17.00
3 amperes	Thibet	17.00
5 amperes	Thickish	17.00
10 amperes	Thielt	18.00
20 amperes	Thienyl	18.00
115 milliampere Galvanometer	Thietsee	18.50

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[This Bulletin replaces Bulletin 503]

Standardize on General Radio Apparatus Throughout

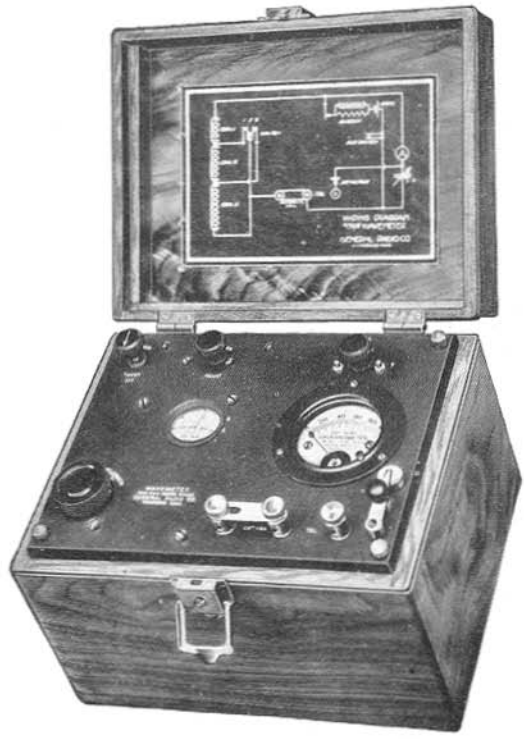
GENERAL RADIO COMPANY

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.

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.

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.

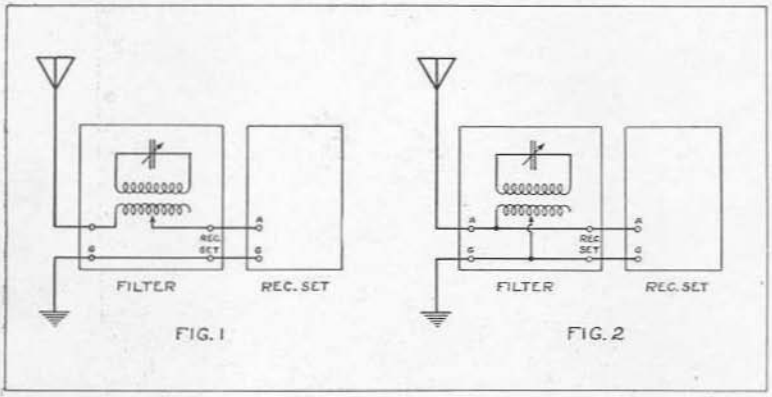


FIG. 1 FIG. 2

OPERATION

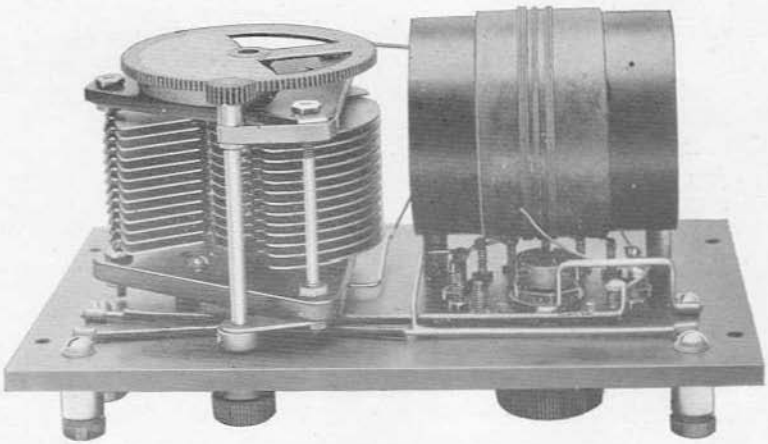
The filter can be used with any antenna connected receiving set to improve the selectivity; the improvement being more noticeable when used with the single circuit type than with the inductively coupled type of receiver. When used with a crystal receiver the operation of the filter is quite simple, but 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 re-tuning 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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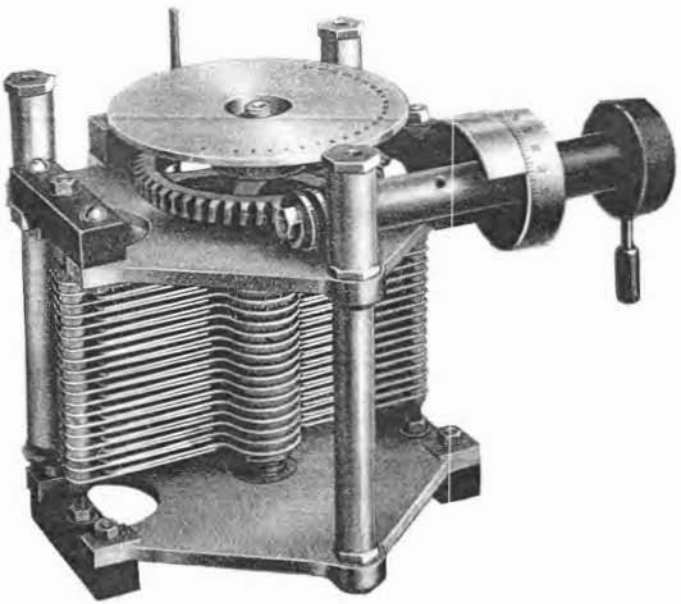
GENERAL RADIO COMPANY

MANUFACTURERS OF

ELECTRICAL AND RADIO LABORATORY APPARATUS

CAMBRIDGE, MASSACHUSETTS

BULLETIN 711 NOVEMBER 1923



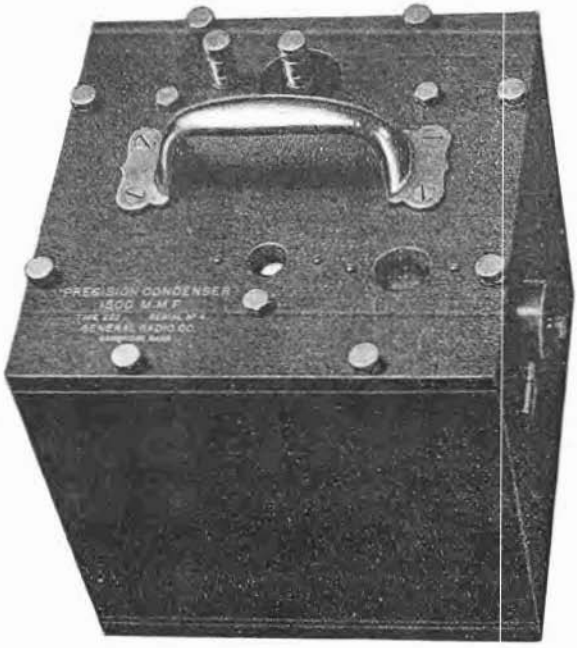
Type 222
PRECISION CONDENSER

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.

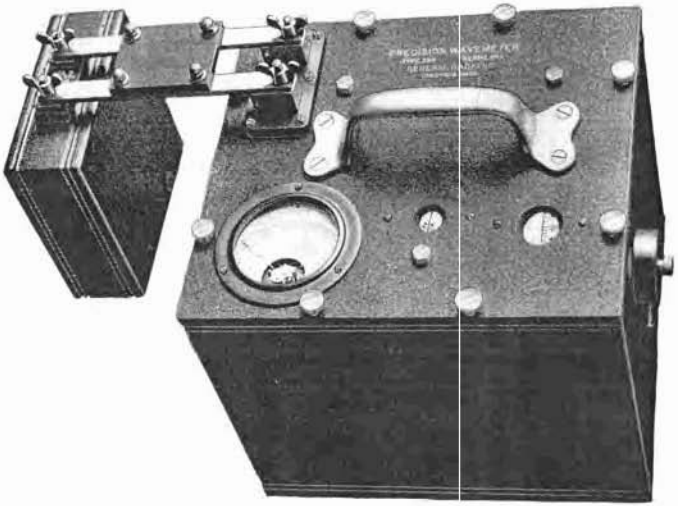
The temperature coefficient of this condenser is practically nil, and there is no change in capacity with frequency. The equivalent series resistance at 1000 cycles and 1000 MMF. is approximately 11 ohms. The breakdown potential is about 1000 volts.

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 $\frac{1}{8}$ 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.

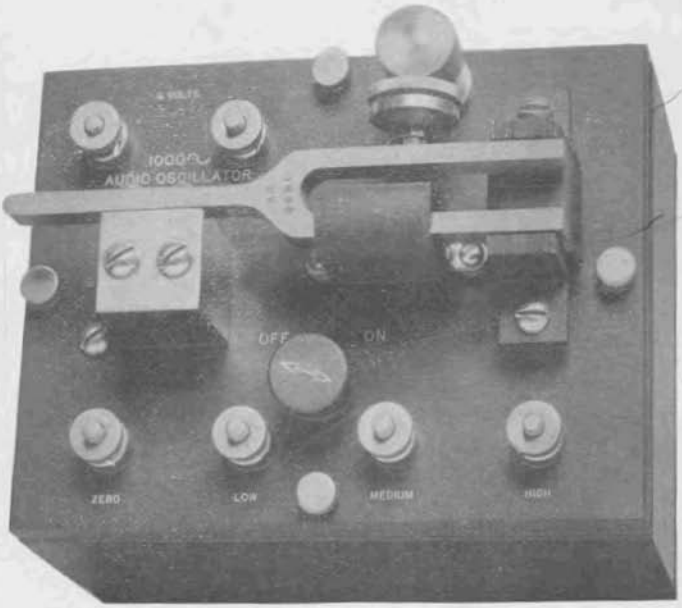
GENERAL RADIO COMPANY

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

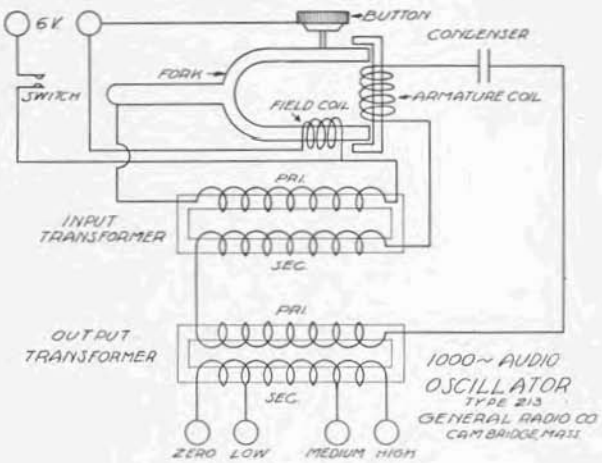
For some capacitance measurements it is desirable to use a high voltage. This increased voltage may be obtained by connecting an inductance and capacitance in series across the high voltage output terminals of the oscillator. By adjusting this circuit to resonance, voltages as high as 50 or 100 may be 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.

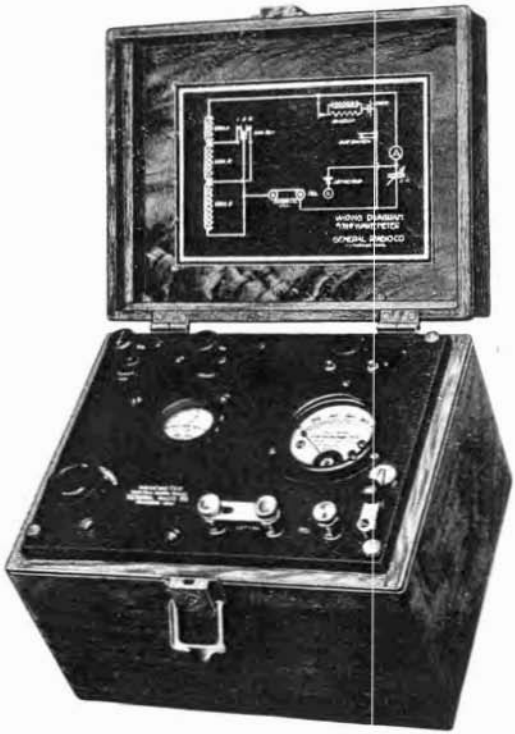
GENERAL RADIO COMPANY

MANUFACTURERS OF

ELECTRICAL AND RADIO LABORATORY APPARATUS

CAMBRIDGE, MASSACHUSETTS

BULLETIN 713 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."

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Standardize on General Radio Apparatus Throughout

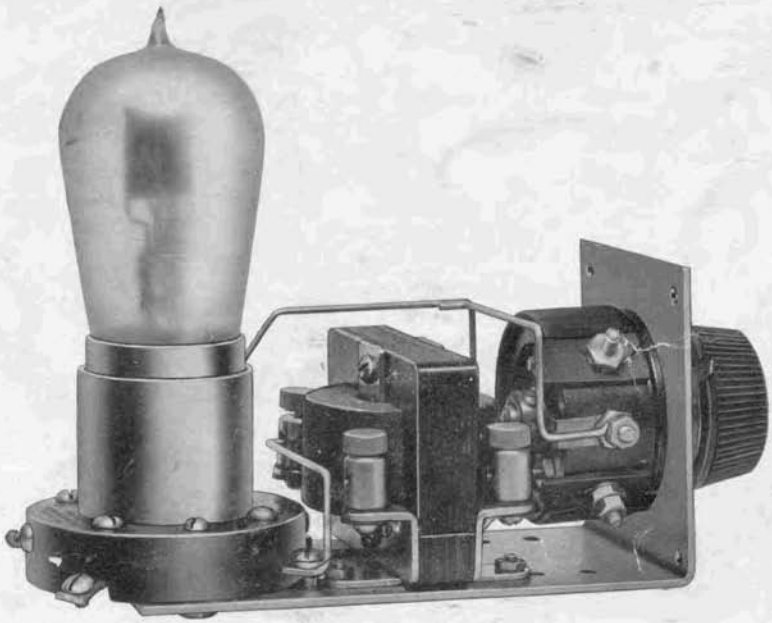
GENERAL RADIO COMPANY

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 unit are 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."

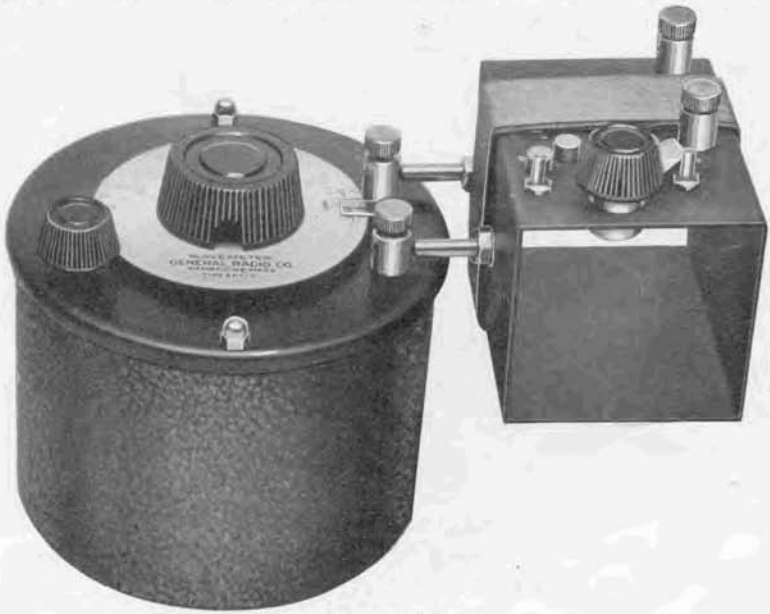
Type 247K 250 MMF. Panel Mounting. Without gear.....$3.00
Dimensions 4″x4″x4″. Weight ⅞ lb.
Code Word: "CARGO."

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%.

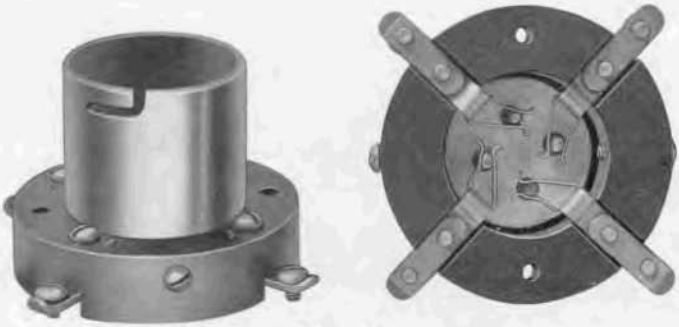
The selectivity of a receiving set is greatly improved by a Radio Filter. The Type 247W wavemeter is ideally adapted for this purpose, since it is provided with a variable coupling coil located beneath the wavemeter winding. This coil may be connected either in series or parallel with the receiving set.

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.

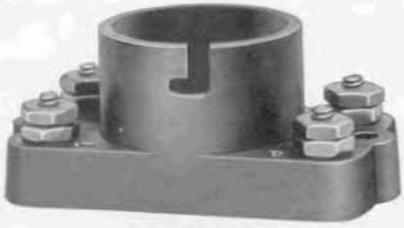
Type 282

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

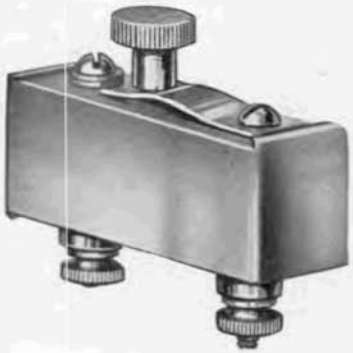
100	Milli-Amps.	MAYOR	Front of Board	$9.00
250	Milli-Amps.	MADAM	Front of Board	7.75
500	Milli-Amps.	MAJOR	Front of Board	7.75
1	Ampere	MANOR	Front of Board	7.75
1.5	Amperes	MISTY	Front of Board	7.75
2.5	Amperes	MAPLE	Front of Board	7.75
5	Amperes	MATIN	Front of Board	7.75
10	Amperes	MAXIM	Front of Board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