

# GENERAL RADIO COMPANY

MANUFACTURERS OF  
HIGH GRADE RADIO LABORATORY APPARATUS  
CAMBRIDGE, MASSACHUSETTS

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BULLETIN 102

JANUARY 1921

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**VARIABLE AIR CONDENSER**  
**Type 101**

For laboratory research work, particularly with circuits carrying currents of radio frequency, it is often desirable to have a variable condenser whose quality is above that of the usual radio experimental type. The losses should be small, and there should be but little change in capacitance with age and with the moderately severe handling to which an experimental condenser is subjected. The Type 101 condensers are built to meet this general laboratory service. These condensers have been manufactured in large quantities for several years and may be found in nearly all of the more important electrical laboratories in this country.

This condenser consists of a set of fixed and a set of rotary plates, both of which are semi-circular. These plates are of heavy aluminum and are spaced sufficiently far apart to prevent short circuiting or appreciable changes in capacitance with age. The end pieces are of heavy moulded bakelite. The shaft is of steel and has large 45 degree angle cone bearings, accurately machined after the assembly of the moving unit. This assures perfect alignment. The bearings

which support the steel shaft are of brass, positively locked in place. When the condenser is completely assembled the moving plates are given a rotation test to insure that the bearings are completely worn in, thus eliminating the chance of any future changing, sticking or binding.

A silvered etched dial with black filled lines and figures is fastened directly to the handle and shaft, rotating with them. The case is of heavy brass with a permanent black crystalline finish. Care is taken to have low resistance connections from both the moving and stationary plates to the binding posts which are mounted on the bakelite top.

Since this condenser is rugged, has low dielectric losses and retains its calibration, it is very useful as a variable standard of capacitance.

All condensers are provided with a label giving maximum and minimum capacitance readings. When so desired, a calibration curve for the entire condenser may be furnished. This calibration is made at 1,000 cycles with an accuracy of .5%. The calibrated condensers are fitted with an 8-inch extension handle for accurate setting. If so desired, however, the extension handle may be furnished with the uncalibrated condensers.

Type 101L Capacitance 1,500 Micromicrofarads .....\$24.00  
Dimensions 7"d x 7". Weight 5¼ lbs.

Code Word "CABIN"

Type 101M Capacitance 3,000 Micromicrofarads .....\$29.00  
Dimensions 7"d x 10". Weight 9 lbs.

Code Word "CADET"

Type 101P Capacitance 5,000 Micromicrofarads .....\$35.00  
Dimensions 7"d x 10". Weight 10 lbs.

Code Word "CANAL"

Calibration curve and extension handle with any of the above condensers .....\$5.50

Extension handle .....\$1.50

These condensers may also be supplied unmounted. Handle, scale, and indicator button are included but no case, top, or binding posts.

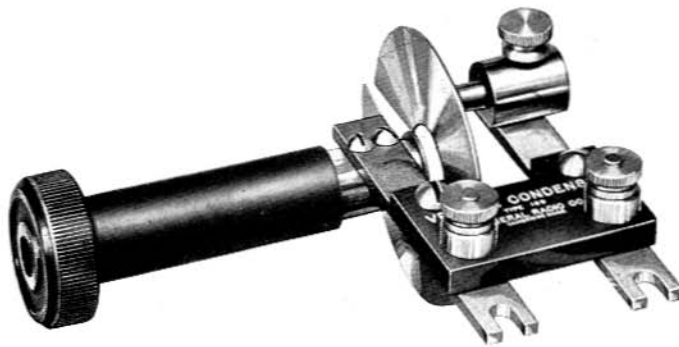
Type 101L Unmounted .....\$18.00  
Code Word "CAMEL"

Type 101M Unmounted .....\$21.50  
Code Word "CANNY"

Type 101P Unmounted .....\$27.50  
Code Word "CANOE"

### MICA AND PAPER CONDENSERS

Because of the large size which would be required, it is impractical to build air condensers larger than 5,000 micro-farads. Above this size mica or low loss paper condensers are preferable. Our line includes both of these types of condensers, special information regarding which will be sent on request.



**VERNIER CONDENSER**  
**Type 169**

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.

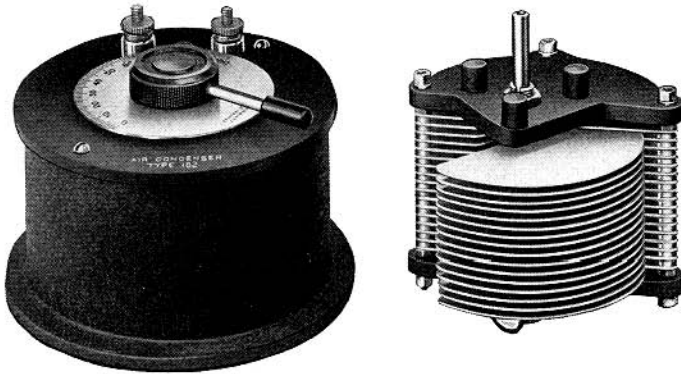
Type 169 Vernier Condenser .....\$8.00  
Dimensions 5½" x 4¼" x 2¾". Weight ¾ lbs.  
Code Word "CUBBY"

**PRECISION CONDENSER**  
**Type 222**

Where great accuracy is desired we recommend the use of our Type 222 Precision Condenser. The construction throughout is unusually heavy and rugged. Dielectric losses are kept at a minimum by the use of a very small amount of low loss solid dielectric which is all placed in a very weak field. The movement of the rotary plates is controlled by a worm and gear. By the use of a primary and of a sub-scale direct readings to one part in 2500 are obtained. This condenser is fully described in Bulletin 702.

Type 222L Capacitance 1,500 Micromicrofarads .....\$90.00  
Dimensions 8¼" x 8¼" x 9". Weight 16 lbs.  
Code Word "COPAL"





**VARIABLE AIR CONDENSER**  
**Type 182**

This condenser embodies many of the desirable features found in the Type 101 condenser. It is, however, smaller and of lower capacitance, being particularly adapted for use in radio receiving sets and wavemeters. The moving plates are so shaped as to obtain a nearly uniform wave-length variation throughout the entire range of the condenser. The case is of heavy brass with a permanent black crystalline finish. This condenser is made in two capacitances, 700 and 1000 micromicrofarads, and is fully described and priced in Bulletin 904.

- |           |   |         |
|-----------|---|---------|
| Type 182A | Capacitance 700 Micromicrofarads . . . . .  | \$12.00 |
|           | Dimensions 5½" d x 4⅛". Weight 2 lbs.       |         |
|           | Code Word "CUDDY"                           |         |
| Type 182E | Capacitance 1000 Micromicrofarads . . . . . | \$13.50 |
|           | Dimensions 5½" d x 5⅛". Weight 2½ lbs.      |         |
|           | Code Word "CANDY"                           |         |

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CAMBRIDGE, MASSACHUSETTS

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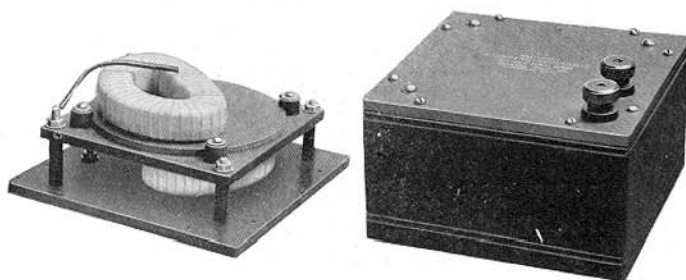
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**BULLETIN 303**

**JANUARY 1921**

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## STANDARDS OF INDUCTANCE Type 106

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. The 1.0 Millihenry and smaller coils have twelve strand windings while seven strands are used on the larger coils. 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 percent. The .05 and .20 Millihenry coils will carry 2.5 amperes indefinitely, the 1 Millihenry coil 2 amperes, and the 5.0 Millihenry coil 1 ampere.

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These inductance standards are mounted in polished oak cases with engraved bakelite panels fitted with insulated binding posts.

Type	Inductance	Code Word	Price
106E	.05 Millihenry	INCUR	\$24.00
106F	.20 Millihenry	INEPT	24.00
106G	1.0 Millihenry	INERT	24.00
106H	5.0 Millihenrys	INFIX	24.00

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

## VARIOMETER

### Type 107

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 spheres 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, but by a simple arrangement of connecting bars these 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.

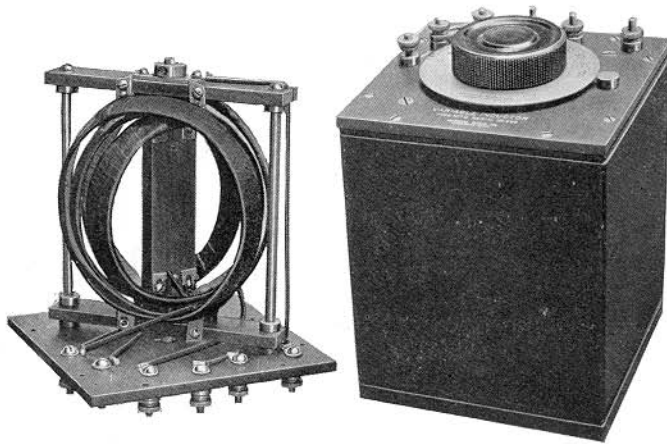
A silvered etched dial with black filled lines and figures indicates the relative position of the coils. When the dial reading is zero, the currents in the two coils are circulating in opposite directions and the inductance is a minimum. When the dial reading is 50, corresponding to a rotation of 90°, 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 for the coils both for the series and for the parallel connections. 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. Ranges other than those listed below can be constructed for a slightly increased cost.



Type 107C	About .008 to .4 M.H. ....	\$24.00
	Carries 3 amperes continuously.	
	Code Word "HAPPY."	
Type 107D	About .12 to 6 M.H. ....	\$24.00
	Carries 1 ampere continuously.	
	Code Word "HARDY."	
Type 107E	About .4 to 20 M.H. ....	\$24.00
	Carries ½ ampere continuously.	
	Code Word "HAVEN."	

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

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

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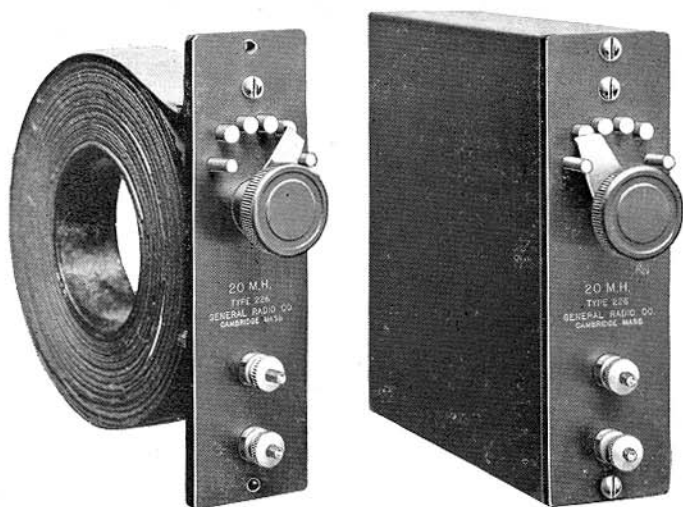
**[This Bulletin replaces Bulletin 301]**

# GENERAL RADIO COMPANY

MANUFACTURERS OF  
ELECTRICAL AND RADIO LABORATORY APPARATUS  
CAMBRIDGE, MASSACHUSETTS

**BULLETIN 304**

**APRIL 1921**



## **FOUR STEP INDUCTOR Type 226**

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

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

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

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

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

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

The ranges covered by these coils when used with one of our type 182E Condensers, which has a maximum capacitance of 1000 micromicrofards, are shown in the following table:

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

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

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**(This Bulletin replaces Bulletin 302)**



# GENERAL RADIO COMPANY

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CAMBRIDGE, MASSACHUSETTS

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**BULLETIN 404**

**JANUARY 1921**

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## **CAPACITY BRIDGE**

### **Type 216**

#### **Description**

There has long been a need for some simple yet reliable method of measuring capacitances as low as a few micro-microfarads 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 accompanying diagram.

The input source E is the General Radio Co. Type 213 1000-cycle Audio Oscillator, described in Bulletin 703. 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 midpoint. 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

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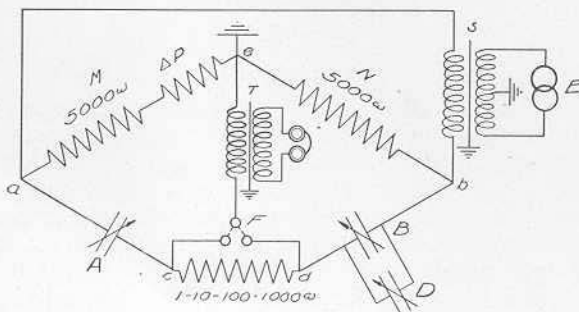


grounded. These ratio arms are made up of equal resistance units wound on thin cards to reduce the inductance and the distributed capacitance. A method, however, is provided for adding resistance units to either the M or N arm in order to get small amounts of unbalancing. A four dial decade resistance box, the units of which are our standard 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 oak. 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.

### 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 the maximum of results. 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 we recommend our Type No. 213 Audio Oscillator 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 micro-microfarads being 160,000 ohms—it is desirable that the detector used to denote the balance point of the bridge have a high impedance. As the impedance at the above frequency 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 micro-microfarad. 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 micro-microfarads. For this work the bridge is first balanced, using capacitances of the order of 1000 micro-microfarads. 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 micro-microfarad. 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.



## 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 micro-microfarads to a precision of one hundredth of a micro-microfarad. 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 micro-microfarads and a phase angle of 48'. When heated to 100° F. the capacitance had increased to 12.25 micro-microfarads 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 M. M. F.....	\$90.00
Dimensions 9" x 8½" x 10". Weight 15 lbs.	
Code Word "COPAL"	
Type 169 Vernier Condenser .....	\$8.00
Dimensions 5½" x 4¼" x 2¾". Weight ¾ lbs.	
Code Word "CUBBY"	
Type 1002A Western Electric Double Head Receivers.....	\$15.00

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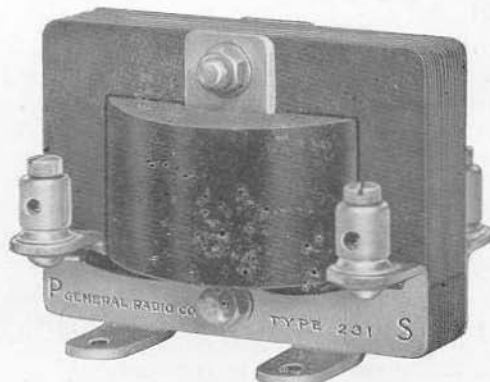


# GENERAL RADIO COMPANY

MANUFACTURERS OF  
ELECTRICAL AND RADIO LABORATORY APPARATUS  
CAMBRIDGE, MASSACHUSETTS

BULLETIN 907

APRIL 1921



## AMPLIFYING TRANSFORMER Type 231A

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

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

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

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

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

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

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

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

Type 231A Amplifying Transformer.....\$5.00  
 Dimensions  $2\frac{5}{8}$ " x  $2\frac{1}{2}$ " x  $2\frac{1}{2}$ ". Weight, 1 lb.  
 Code Word: "TUTOR."

## MODULATION TRANSFORMER

### Type 231M

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

Type 231M. Modulation Transformer.....\$5.00  
 Dimensions  $2\frac{5}{8}$ " x  $2\frac{1}{2}$ " x  $2\frac{1}{2}$ ". Weight, 1 lb.  
 Code Word: "TUNIC."



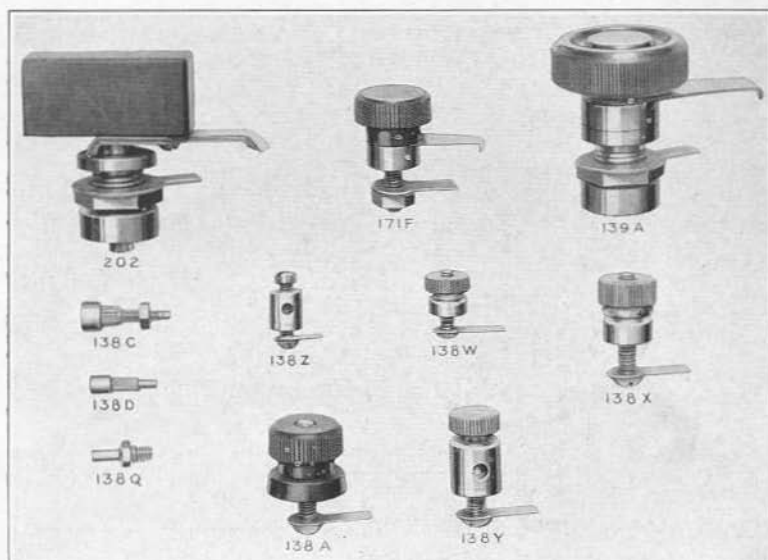


# GENERAL RADIO COMPANY

MANUFACTURERS OF  
ELECTRICAL AND RADIO LABORATORY APPARATUS  
CAMBRIDGE, MASSACHUSETTS

BULLETIN 908

MAY 1921



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

## BINDING POSTS

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

[Page 935]





## SWITCHES AND PARTS

Type	Description	Price
139A	Multiple Leaf Switch $1\frac{3}{8}$ " radius	\$0.95
171F	Single Leaf Switch $\frac{7}{8}$ " radius	0.40
202	Low Contact Resistance Switch $1\frac{3}{8}$ " radius	1.25
138C	$\frac{5}{16}$ " Contact for 139A or 202 Switches	0.05
138D	$\frac{3}{16}$ " Contact for 171F Switch	0.04
138Q	Switch Stop	0.05

## DIALS AND KNOBS

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

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

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

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

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

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

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

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

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

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

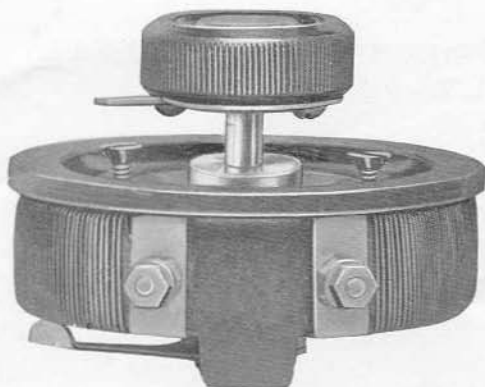
## VACUUM TUBES

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

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

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

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



### TYPE 214 RHEOSTAT

The Type 214 Rheostat is a convenient, practical instrument for experimental service or for permanent installations. It is made in two types, 214A for back of panel mounting, and 214B for front of panel mounting and portable use. The illustration shows the back of panel type. In this type when mounted, only the knob and pointer project through the panel. The shaft may be adjusted for any thickness of panel up to  $\frac{3}{8}$ ". Ruggedness of construction and smoothness of operation make this rheostat especially adapted for laboratory and radio use. There is no grating or clicking of the contact arm.

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

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

Dimensions 3" d. x  $2\frac{1}{4}$ ". Weight 7 oz.

Code Word

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

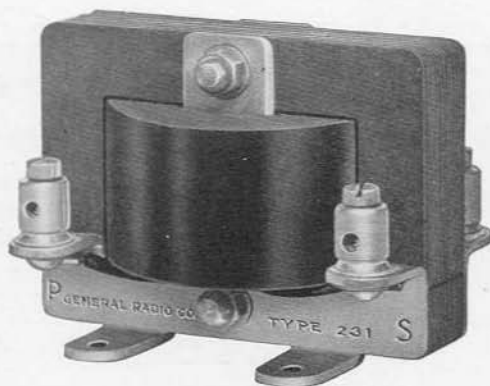
Special resistances up to 400 ohms may also be supplied, but the total energy absorbed should not exceed 16 watts.



## Type 231A AMPLIFYING TRANSFORMER

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

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



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

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

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

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

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

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

Type 231A Amplifying Transformer .....\$5.00

Dimensions  $2\frac{5}{8}$ " x  $2\frac{1}{2}$ " x  $2\frac{1}{2}$ ". Weight 1 lb.

Code Word : "TUTOR."

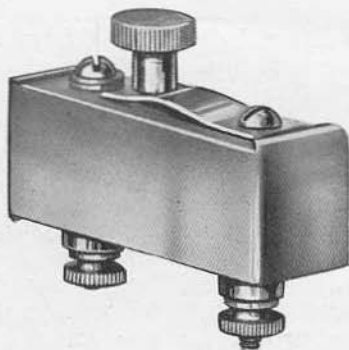
### Type 231M MODULATION TRANSFORMER

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 hundreds thousand ohms, while that of a telephone transmitter is but a few ohms. A modulation transformer serves to adapt the telephone transmitter impedance to that of the input circuit of the tube. The success of a radio telephone installation depends not only on the value of the antenna current, but also on how completely that current is modulated. Our Type 231M transformer has been designed to give the maximum modulation which is possible without distortion.

Type 231M Modulation Transformer .....\$5.00

Dimensions  $2\frac{5}{8}$ " x  $2\frac{1}{2}$ " x  $2\frac{1}{2}$ ". Weight, 1 lb.

Code Words: "TUNIC."



### TYPE 178 HIGH FREQUENCY BUZZER

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

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

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

Dimensions 2" x 1 $\frac{3}{4}$ " x 1". Weight 3 oz.

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

### TYPE 1002A WESTERN ELECTRIC HEAD PHONES

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

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





### TYPE 174 DIRECT READING WAVEMETER

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

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

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

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

Type 174 Direct Reading Wavemeter .....\$68.00

Code Word: "WITTY."

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

## Type 211 VACUUM TUBE DETECTOR

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



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

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

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

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

Type 211 Detector Set .....\$32.00

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

Code Word: "DETER."

### VACUUM TUBE AMPLIFIERS Types 206 and 215



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



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



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

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

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

Code Word: "AMPLE."

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

Code Word: "ANNEX."

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



### TYPE 156 VACUUM TUBE SOCKET

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

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

Type 156 Socket .....\$1.50

Code Word: "SOBER."

Dimensions  $2\frac{1}{2}$ " x  $2\frac{1}{2}$ " x  $1\frac{3}{4}$ ". Weight 4 oz.

### TYPE 127 HOT WIRE AMMETERS

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

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

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

These instruments are made in three types, the flush mounting for use on panels, the front-of-board mounting for use on switchboards, and the portable type for general use. In mounting the flush type of meter an opening in the panel  $2\frac{5}{8}$  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
¼ Amp.	MERCY	Flush Mounting	7.75
½ Amp.	MERIT	Flush Mounting	7.75
1 Amp.	MERRY	Flush Mounting	7.75
2.5 Amps.	MINOR	Flush Mounting	7.75
5 Amps.	MINIM	Flush Mounting	7.75
10 Amps.	MINNY	Flush Mounting	7.75
Galvanometer	MITER	Flush Mounting	7.25

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

### TYPE 127B

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

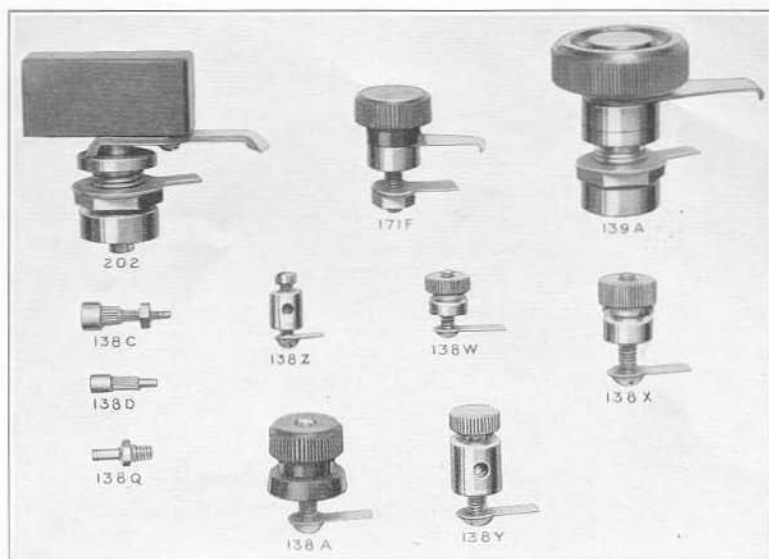
Dimensions 3 in. d. x 1½ in. Weight 9 oz.

### TYPE 127C

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

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

## STANDARD PARTS



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

### BINDING POSTS

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

### SWITCHES AND PARTS

Type	Description	Price
139A	Multiple Leaf Switch $1\frac{3}{8}$ " radius	\$0.95
171F	Single Leaf Switch $\frac{7}{8}$ " radius	0.40
202	Low Contact Resistance Switch $1\frac{3}{8}$ " radius	1.25
138C	$\frac{5}{16}$ " Contact for 139A or 202 Switches	0.05
138D	$\frac{3}{16}$ " Contact for 171F Switch	0.04
138Q	Switch Stop	0.05

## DIALS AND KNOBS

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

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

*Standardize on General Radio Apparatus Throughout.*



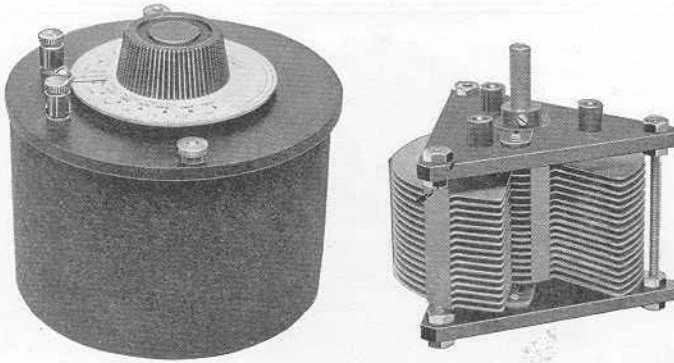
*The instruments listed in this Bulletin may be obtained directly from our factory at Cambridge, Massachusetts, or may be purchased through your local dealer.*

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## 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:

[Page 962]

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

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

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

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

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

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

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

Type 247A Condenser, completely mounted .....\$5.50  
Dimensions  $4\frac{1}{2}$ "D x  $3\frac{1}{2}$ ". Weight  $1\frac{3}{4}$  lb.

Code Word "CRONY."

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

Type 247B Condenser, unmounted .....\$3.25  
Dimensions  $3\frac{3}{4}$ " x  $3\frac{3}{4}$ " x  $3\frac{1}{2}$ ". Weight 1 lb.

Code Word "CRUEL."

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

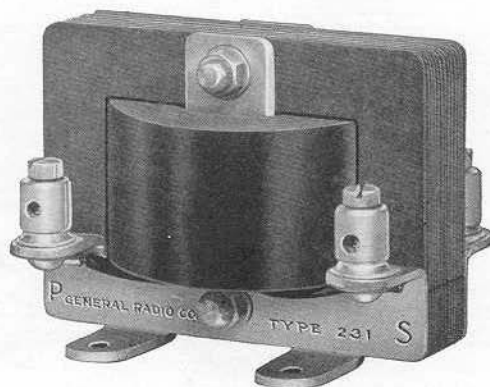
Unless otherwise specified the dial supplied with the Type 247B Condenser will not have the capacity scale added. The capacity scale will be added, without charge, whenever specified.



## Type 231A AMPLIFYING TRANSFORMER

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

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



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

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

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

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

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

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

Type 231A Amplifying Transformer .....\$5.00

Dimensions  $2\frac{5}{8}$ " x  $2\frac{1}{2}$ " x  $2\frac{1}{2}$ ". 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 hundreds thousand ohms, while that of a telephone transmitter is but a few ohms. A modulation transformer serves to adapt the telephone transmitter impedance to that of the input circuit of the tube. The success of a radio telephone installation depends not only on the value of the antenna current, but also on how completely that current is modulated. Our Type 231M transformer has been designed to give the maximum modulation which is possible without distortion.

Type 231M Modulation Transformer .....\$5.00

Dimensions  $2\frac{5}{8}$ " x  $2\frac{1}{2}$ " x  $2\frac{1}{2}$ ". Weight, 1 lb.

Code Words : "TUNIC."

## TYPE 127 HOT WIRE AMMETERS

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



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

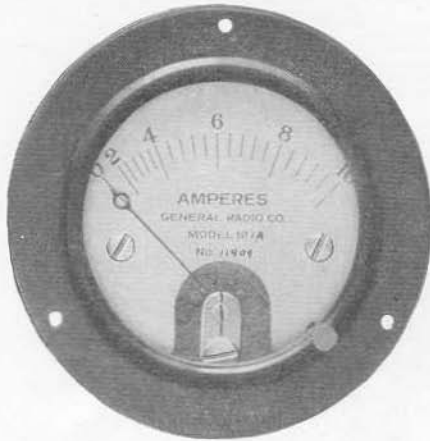
The type of multiplying action is such that a more uniform scale is obtained than with many hot wire meters. These meters have been corrected for temperature so that there is very little shift of zero. Any necessary correction may be made by adjusting a knurled screw.

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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  $2\frac{3}{8}$  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
$\frac{1}{4}$ Amp.	MERCY	Flush Mounting	7.75
$\frac{1}{2}$ Amp.	MERIT	Flush Mounting	7.75
1 Amp.	MERRY	Flush Mounting	7.75
2.5 Amps.	MINOR	Flush Mounting	7.75
5 Amps.	MINIM	Flush Mounting	7.75
10 Amps.	MINNY	Flush Mounting	7.75
Galvanometer	MITER	Flush Mounting	7.25

Dimensions 3 in. x  $1\frac{1}{2}$  in. Weight  $9\frac{1}{2}$  oz.

#### TYPE 127B

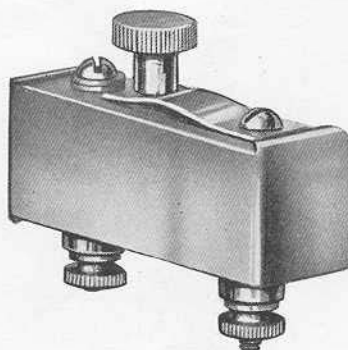
Range	Code Word	Case	Price
100 Milli-Amps.	MAYOR	Front of Board	9.00
$\frac{1}{4}$ Amp.	MADAM	Front of Board	7.75
$\frac{1}{2}$ Amp.	MAJOR	Front of Board	7.75
1 Amp.	MANOR	Front of Board	7.75
2.5 Amps.	MAPLE	Front of Board	7.75
5 Amps.	MATIN	Front of Board	7.75
10 Amps.	MAXIM	Front of Board	7.75
Galvanometer	MAGIC	Front of Board	7.25

Dimensions 3 in. d. x  $1\frac{1}{2}$  in. Weight 9 oz.

### TYPE 127C

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

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



### TYPE 178 HIGH FREQUENCY BUZZER

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

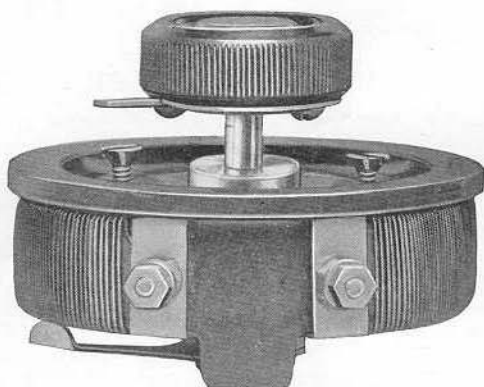
The frequency is approximately 800 cycles, but depends on the setting of the knurled adjusting screw. As the current required for the operation of the buzzer is approximately only 30 milli-amperes, it may be operated for long periods of time from small batteries. One dry cell will provide sufficient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

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

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

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

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### TYPE 214 RHEOSTAT

The Type 214 Rheostat is a convenient, practical instrument for experimental service or for permanent installations. It is made in two types, 214A for back of panel mounting, and 214B for front of panel mounting and portable use. The illustration shows the back of panel type. In this type when mounted, only the knob and pointer project through the panel. The shaft may be adjusted for any thickness of panel up to  $\frac{3}{8}$ ". Ruggedness of construction and smoothness of operation make this rheostat especially adapted for laboratory and radio use. There is no grating or clicking of the contact arm.

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

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

Dimensions 3" d. x 2 $\frac{1}{4}$ ". Weight 7 oz.

#### Code Word

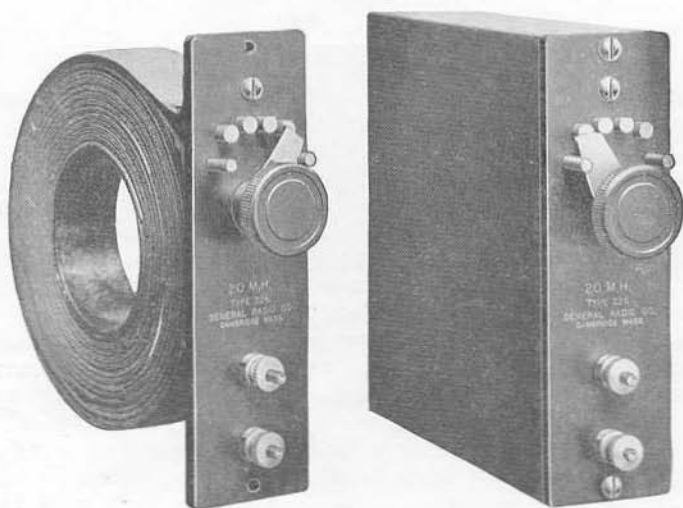
Resistance	Current	Type 214A	Type 214B	Price
2 ohms	2.5 amp.	RUDDY	RUMOR	\$2.50
7 ohms	1.5 amp.	RURAL	RUSTY	\$2.50
80 ohms	0.3 amp.	REVEL	RIFLE	\$3.50
400 ohms	0.1 amp.	RIGID	RIVAL	\$3.50
80 ohms	Potentiometer	RIVET	ROMAN	\$4.00
400 ohms	Potentiometer	ROSIN	ROWEL	\$4.00

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



## Type 226 FOUR STEP INDUCTOR

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



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

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

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

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

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

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

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

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

### VACUUM TUBES

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

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

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

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

### WESTERN ELECTRIC HEAD PHONES

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

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

## Types 206 and 215 VACUUM TUBE AMPLIFIERS

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



**Type 206  
ONE STEP AMPLIFIER**

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

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

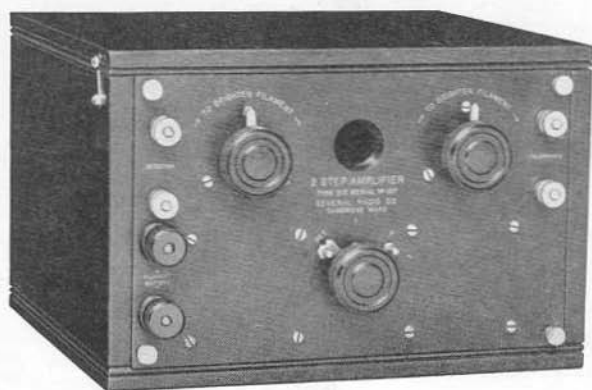
[Page 972]



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

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

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



**Type 215  
TWO STEP AMPLIFIER**

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

Type 206 1 Step Amplifier .....\$28.00

Dimensions 8" x 7" x 9. Weight 6¼ lbs.

Code Word: "AMPLE."

Type 215 2 Step Amplifier .....\$50.00

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

Code Word: "ANNEX."

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

Navy type Everready Batteries, 22 volts .....\$3.00

Radiotron UV201 Vacuum Tubes ..... 6.50



### TYPE 174 DIRECT READING WAVEMETER

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

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

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

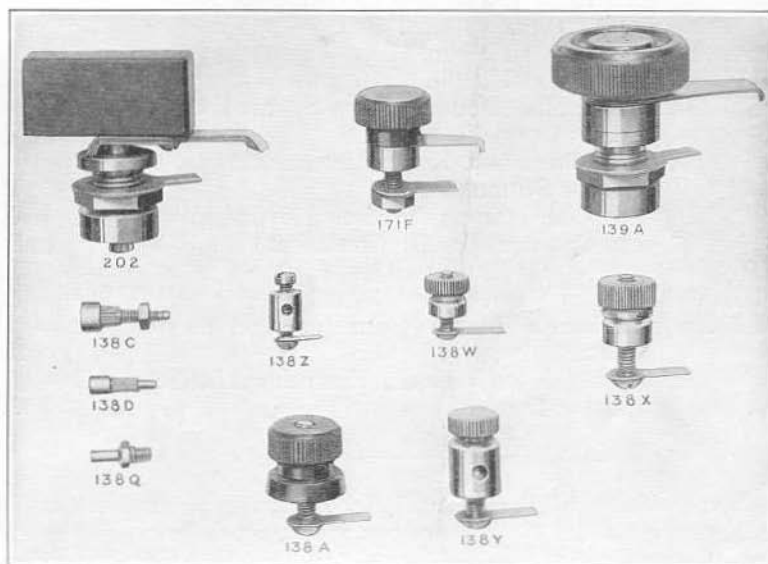
Particular care has been given to the mechanical construction and to the appearance of this instrument. All of the equipment is mounted on a bakelite panel and enclosed in a polished walnut carrying case. The metal parts are finished in polished nickel.

Type 174 Direct Reading Wavemeter .....\$68.00

Code Word: "WITTY."

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

## STANDARD PARTS



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

### BINDING POSTS

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

### SWITCHES AND PARTS

Type	Description	Price
139A	Multiple Leaf Switch $1\frac{3}{8}$ " radius	\$0.95
171F	Single Leaf Switch $\frac{7}{8}$ " radius	0.40
202	Low Contact Resistance Switch $1\frac{3}{8}$ " radius	1.25
138C	$5/16$ " Contact for 139A or 202 Switches	0.05
138D	$3/16$ " Contact for 171F Switch	0.04
138Q	Switch Stop	0.05



## DIALS AND KNOBS

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

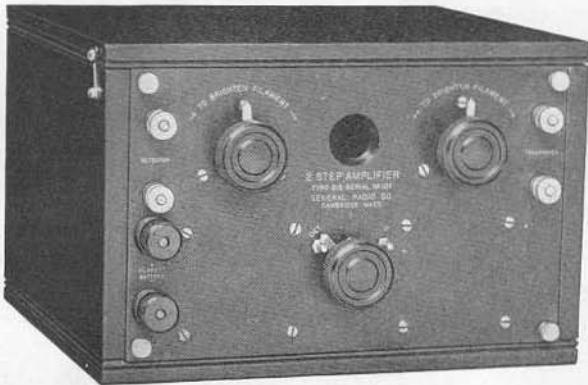
The products of the General Radio Company cover a complete line of radio and electrical laboratory apparatus. Information and bulletins of special apparatus will be sent on request. Our line includes the following: Variable Air Condensers, Vernier Condenser, Standard Condensers, Decade Condensers, Variometers,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

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

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

*Standardize on General Radio Apparatus Throughout.*

5/24/87



**Type 215**  
**TWO-STEP AMPLIFIER**

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

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

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

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

The above price does not include either vacuum tubes or batteries.  
Navy type Eveready Batteries, 22 volts .....\$3.00  
Radiotron UV-201 Vacuum Tubes ..... 6.50

## Type 127 HOT WIRE AMMETERS

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



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

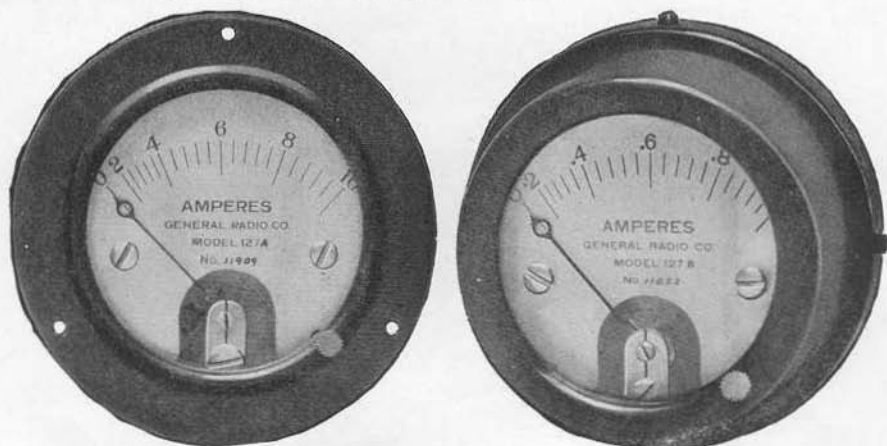
The type of multiplying action is such that a more uniform scale is obtained than with many hot wire meters. These meters have been corrected for temperature so that there is very little shift of zero. Any necessary correction may be made by adjusting a knurled screw.

[Page 980]



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  $2\frac{5}{8}$  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
$\frac{1}{4}$ Amp.	MERCY	Flush Mounting	7.75
$\frac{1}{2}$ Amp.	MERIT	Flush Mounting	7.75
1 Amp.	MERRY	Flush Mounting	7.75
2.5 Amps.	MINOR	Flush Mounting	7.75
5 Amps.	MINIM	Flush Mounting	7.75
10 Amps.	MINNY	Flush Mounting	7.75
Galvanometer	MITER	Flush Mounting	7.25

Dimensions 3" d. x  $1\frac{1}{2}$ ". Weight  $9\frac{1}{2}$  oz.

#### Type 127B

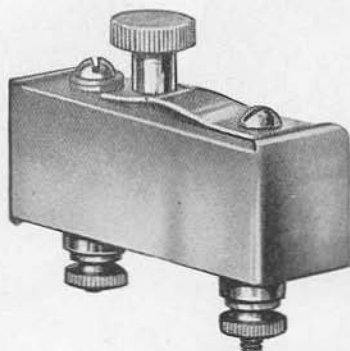
Range	Code Word	Case	Price
100 Milli-Amps.	MAYOR	Front of Board	\$9.00
$\frac{1}{4}$ Amp.	MADAM	Front of Board	7.75
$\frac{1}{2}$ Amp.	MAJOR	Front of Board	7.75
1 Amp.	MAÑOR	Front of Board	7.75
2.5 Amps.	MAPLE	Front of Board	7.75
5 Amps.	MATIN	Front of Board	7.75
10 Amps.	MAXIM	Front of Board	7.75
Galvanometer	MAGIC	Front of Board	7.25

Dimensions 3" d. x  $1\frac{1}{2}$ ". Weight 9 oz.

### Type 127C

Range	Code Word	Case	Price
100 Milli-Amps.	MUGGY	Portable	\$10.00
1/4 Amp.	MOCHA	Portable	9.00
1/2 Amp.	MOGUL	Portable	9.00
1 Amp.	MOLAR	Portable	9.00
2.5 Amps.	MOTOR	Portable	9.00
5 Amps.	MUMMY	Portable	9.00
10 Amps.	MUSTY	Portable	9.00
Galvanometer	MOTTO	Portable	8.50

Dimensions 3" x 4" x 1 1/2". Weight 10 1/2 oz.



### Type 178

#### HIGH FREQUENCY BUZZER

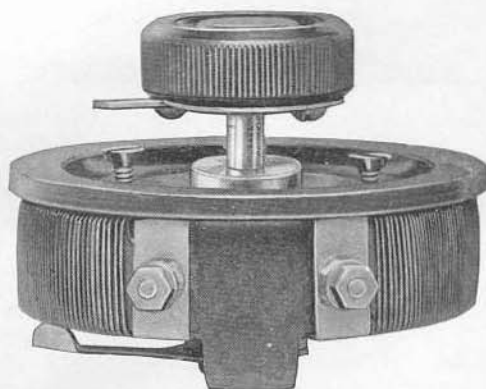
This buzzer has been designed for both laboratory and radio use. It combines pureness of tone, simplicity of adjustment and durability.

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

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

Dimensions 2" x 1 3/4" x 1". Weight 3 oz.

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



**Type 214  
RHEOSTAT**

The Type 214 Rheostat is a convenient, practical instrument for experimental service or for permanent installations. It is made in two types, 214A for back of panel mounting, and 214B for front of panel mounting and portable use. The illustration shows the back of panel type. In this type when mounted, only the knob and pointer project through the panel. The shaft may be adjusted for any thickness of panel up to  $\frac{3}{8}$ ". Ruggedness of construction and smoothness of operation make this rheostat especially adapted for laboratory and radio use. There is no grating or clicking of the contact arm.

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

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

Dimensions 3" d. x  $2\frac{1}{4}$ ". Weight 7 oz.

Code Word

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

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

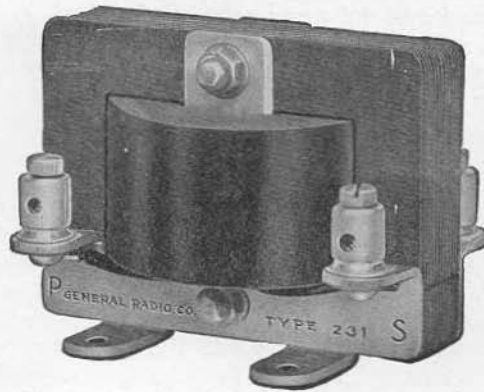
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## Type 231A AMPLIFYING TRANSFORMER

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

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



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

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

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

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

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

Aside from its excellent electrical characteristics, this transformer is well designed mechanically. It is compact, and by means of the four projecting feet, each with a screw hole, may be mounted in any position. The core and coil are finished in black, while the brackets and binding posts are nicked. 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  $2\frac{5}{8}$ " x  $2\frac{1}{2}$ " x  $2\frac{1}{2}$ ". Weight 1 lb.  
Code Word: "TUTOR."

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### Type 231M

#### MODULATION TRANSFORMER

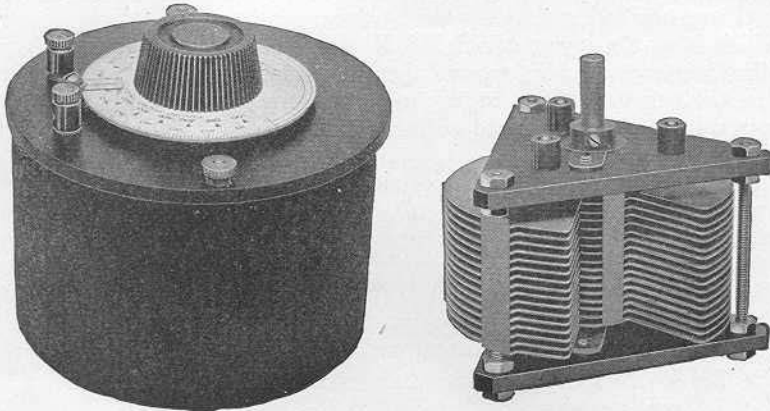
This transformer is similar in general design to the Type 231A amplifying transformer, the only difference being in the winding. Its windings have been designed particularly for use with the Radiotron UV-202 five-watt transmitting tubes and other tubes of similar characteristics. To get the maximum modulation, 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  $2\frac{5}{8}$ " x  $2\frac{1}{2}$ " x  $2\frac{1}{2}$ ". Weight 1 lb.  
Code Word: "TUNIC."



**Type 247**  
**VARIABLE AIR CONDENSER**

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



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

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

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

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**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.

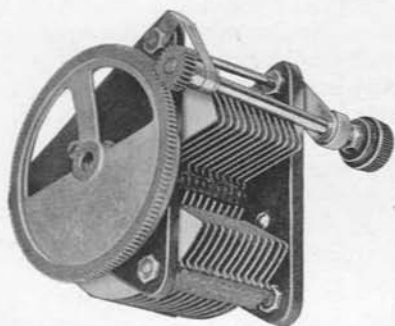
**PLATES SOLDERED TOGETHER:** In order that the plate resistance may be kept constant and that the capacity always will remain the same the plates of each unit of the condenser are soldered together.

**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 crystal-line 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.



than with the older two-adjustment vernier combination.

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

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

Type 247A	1000 MMF. Mounted. Without gear .....	\$6.00
	Dimensions 5" x 5" x 4½". Weight 1¾ lbs.	
	Code Word: "CRONY."	
Type 247B	1000 MMF. Unmounted. Without gear .....	\$3.75
	Dimensions 4" x 4" x 4½". Weight 1 lb.	
	Code Word: "CRUEL."	
Type 247C	1000 MMF. Mounted. With gear .....	\$7.75
	Dimensions 5" x 5" x 4½". Weight 2 lbs.	
	Code Word: "CYCLE."	
Type 247D	1000 MMF. Unmounted. With gear .....	\$5.50
	Dimensions 4" x 4" x 4½". Weight 1½ lbs.	
	Code Word: "CUBIT."	
Type 247E	500 MMF. Mounted. Without gear .....	\$5.50
	Dimensions 5" x 5" x 4½". Weight 1¾ lbs.	
	Code Word: "COUPE."	
Type 247F	500 MMF. Unmounted. Without gear .....	\$3.25
	Dimensions 4" x 4" x 4½". Weight 1 lb.	
	Code Word: "COCOA."	
Type 247G	500 MMF. Mounted. With gear .....	\$7.25
	Dimensions 5" x 5" x 5½". Weight 2 lbs.	
	Code Word: "COLIC."	
Type 247H	500 MMF. Unmounted. With gear .....	\$5.00
	Dimensions 4" x 4" x 4½". Weight 1½ lbs.	
	Code Word: "COMIC."	
Knob and dial, without capacity graduations, and indicator button for use with unmounted condenser .....		\$.50
Gear, pinion, pinion shaft and mounting supports, per set .....		\$1.75

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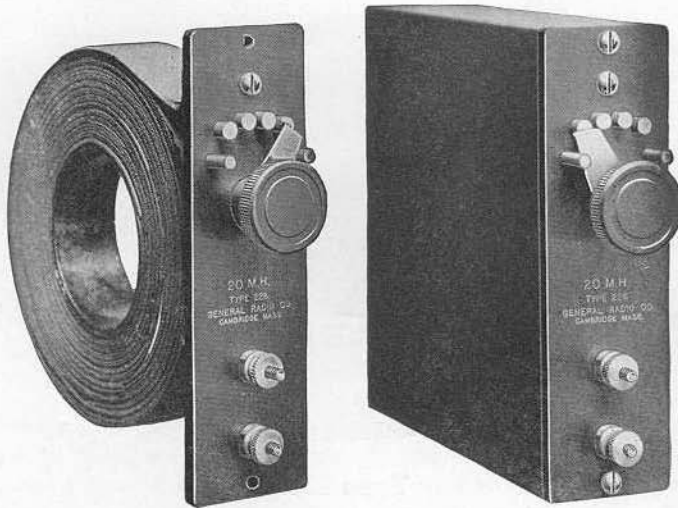
### Type 226 FOUR STEP INDUCTOR

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

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



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



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

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

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

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

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

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



**Type 1002C**

**WESTERN ELECTRIC HEAD PHONES**

This receiver, formerly known as the "P11," was adopted as standard by both the Army and Navy during the war. Combining as it does, sensitivity with great ruggedness, it is unusually well adapted to use in the laboratory and in the receiving station.  
Price, complete with cord .....\$12.00



**Type 156**

**VACUUM TUBE SOCKET**

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

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

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

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

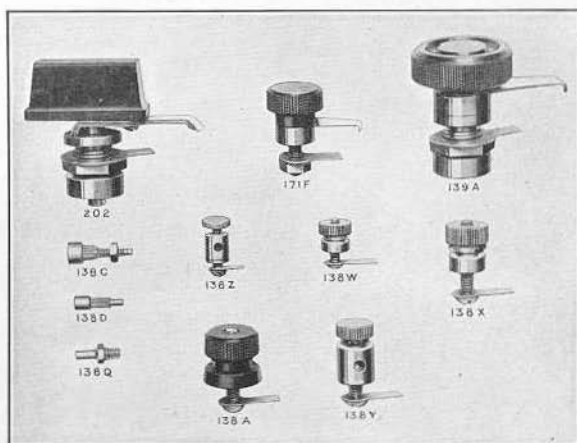
Type 156 Socket .....\$1.25

Code Word: "SOBER."

Dimensions  $2\frac{1}{2}$ " x  $2\frac{1}{2}$ " x  $1\frac{3}{4}$ ". Weight 4 oz.

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## 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 $1\frac{3}{8}$ " radius	\$0.95
171F	Single Leaf Switch $\frac{7}{8}$ " radius	0.40
202	Low Contact Resistance Switch $1\frac{3}{8}$ " radius	1.25
138C	$\frac{5}{16}$ " Contact for 139A or 202 Switches	0.05
138D	$\frac{3}{16}$ " Contact for 171F Switch	0.04
138Q	Switch Stop	0.05

## DIALS AND KNOBS

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

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

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

### This Bulletin replaces Bulletin 911

*Standardize on General Radio Apparatus Throughout.*