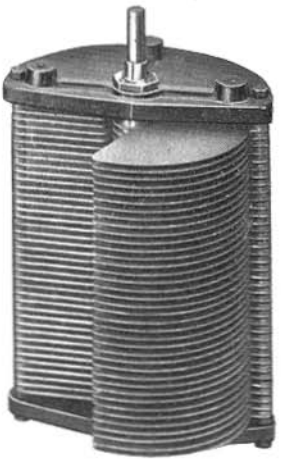
GENERAL RADIO COMPANY

MANUFACTURERS OF

HIGH GRADE RADIO LABORATORY APPARATUS

CAMBRIDGE, MASSACHUSETTS

BULLETIN 101 **JUNE 1920**



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 crystaline 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."

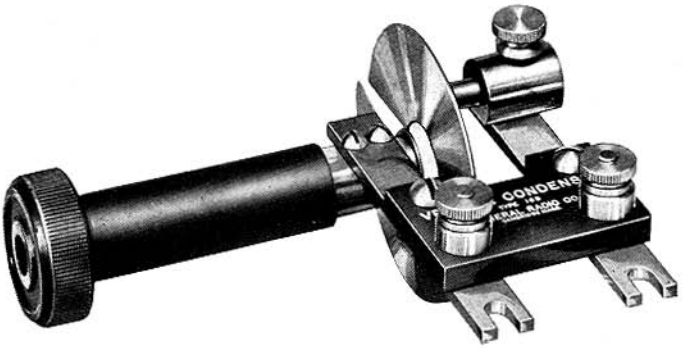
Calibration curve and extension handle with any of the above condensers $5.50

Extension handle $1.50

MICA CONDENSERS

Because of the large size which would be required, it is impractical to build air condensers larger than 5000 micromicrofarads. Above this size mica condensers are preferable. Our line includes two types of mica condensers, the Type 221 which are single unit secondary standards adjusted to better than .5%, and the Type 219 decade condenser adjusted to approximately 1%.

The decade condenser consists of one ten section unit with a total capacitance of .1 microfarad, and one ten section unit with a total capacitance of 1.0 microfarad. The capacitance of the decade units is controlled by a rotary switch, thus permitting the obtaining of any capacitance from .01 microfarad to 1.1 microfarads by changes of .01 microfarad. These condensers will stand 1000 volts and are mounted in polished oak cases. They are described in detail in Bulletin 102.



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.

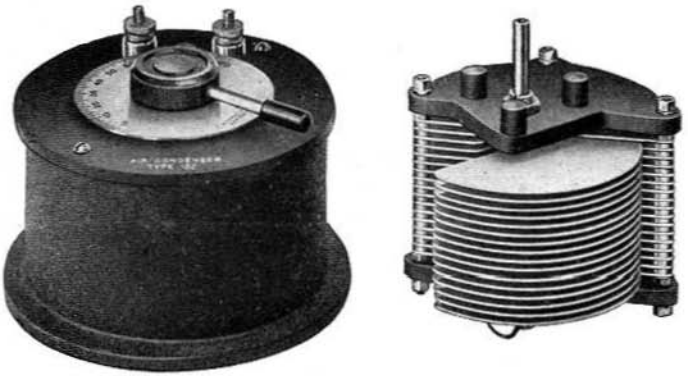
This condenser is also useful in making measurements of very small capacitances, such as are possible with our Type 216 Capacity Bridge.

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 1500 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 crystaline finish. This condenser is made in two capacitances, 700 and 1000 micromicrofarads, and is fully described and priced in Bulletin 901.

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.

GENERAL RADIO COMPANY

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HIGH GRADE RADIO LABORATORY APPARATUS

CAMBRIDGE, MASSACHUSETTS

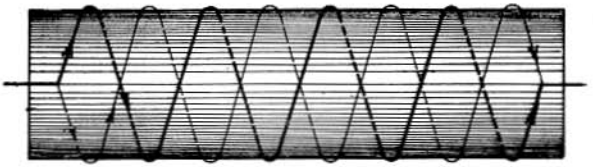
BULLETIN 201 **APRIL 1920**

STANDARDS OF RESISTANCE AND DECADE RESISTANCE BOXES

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

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

Several methods have been used to reduce the inductance and distributed capacitance of resistance units. The Aryton-Perry method used in our coils is not only satisfactory electrically, but also mechanically. This method is illustrated by the diagram. The winding is



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

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

DECADE RESISTANCE BOXES
Type 102

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

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

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

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

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

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

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

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

STANDARDS OF RESISTANCE
Type 133

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

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

Dimensions 3″ d. x 2¼″. Weight 11 oz.

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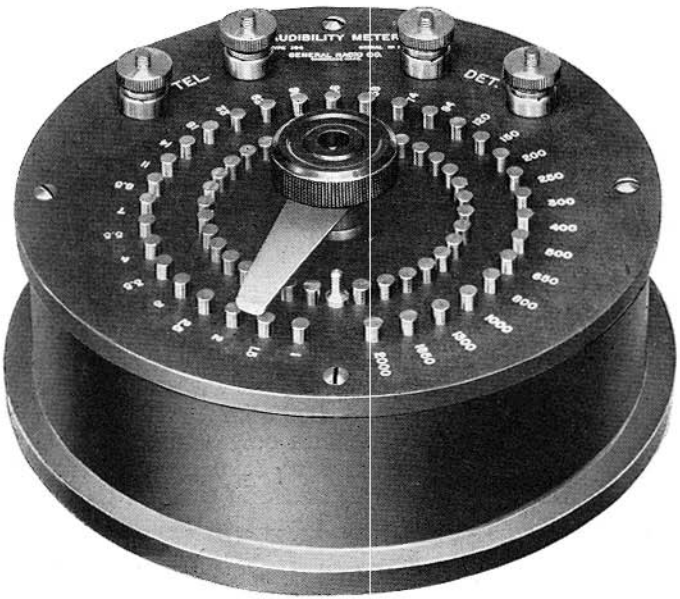
CAMBRIDGE, MASSACHUSETTS

BULLETIN 202 **APRIL 1920**



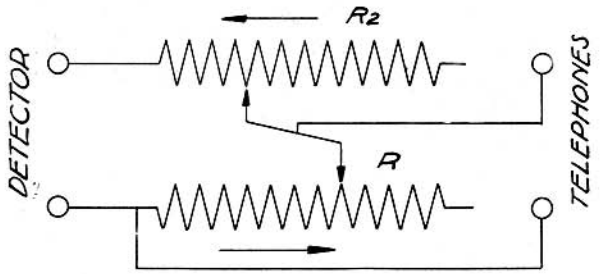
AUDIBILITY METER

Type 164

If a telephone receiver in which signals are being received is shunted by a resistance until the signals are just audible, the ratio of the current in the telephone to the current in the shunt is an indication of the strength of the signals. For instance, if the signal is just audible when 99% of the detector current flows through the shunt and 1% through the telephone receivers, the signal is said to have an audibility of 100. If S is the impedance of the shunt and T the impedance of the telephone receivers the audibility constant is given by the equation:

$$K = \frac{S + T}{S}$$

The increasing use of oscillating circuits for vacuum tube detectors has necessitated the development of a special type of meter for comparing the audibilities of signals. This is because the oscillating circuits are affected by changes in their constants, very slight changes often causing variations of telephone current quite out of proportion to the changes introduced. A series resistance must be added in the plate circuit to compensate for the reduction in resistance of that circuit caused by the shunting of the telephone receivers. The elementary connections of this meter are shown in the diagram. R is the resistance used to shunt the telephone receivers and R_2 is the compensating resistance. As R decreases, R_2 increases.



The Type 164 Audibility Meter is designed to keep the impedance of the oscillating circuit practically constant when used at 1000 cycles. It is adapted for use with any good 2000 ohm telephone receiver. This meter consists of two sets of resistance units with thirty-two taps and reads directly in audibilities from 1 to 2000 by approximately 25% steps. As the first step has no resistance in shunt with the telephone receivers, the audibility meter may be left permanently connected in the circuit.

This instrument is mounted in a polished oak case with engraved bakelite panel. The metal parts are finished in polished nickel. The contact arm is of laminated phosphor bronze and insures perfect contact.

Type 164 Audibility Meter $36.00

Dimensions $7\frac{5}{16}$" d. x 4". Weight 3 lbs.

Code Word "AWAKE."

PHANTOM ANTENNA RESISTOR

Type 125

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

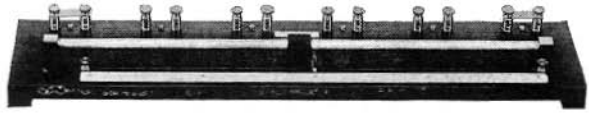
These units are wound on asbestos-board forms, mounted vertically, an arrangement which insures a good circulation of air. The resistance material is in the form of a ribbon, and has a very low temperature co-efficient of resistance and a constant resistance up to very high frequencies. The inductance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

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

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

Type 125A Phantom Antenna Resistance.....$15.00
Dimensions 7¾" x 6" x 4¼". Weight 3¼ lbs.
Code Word "RAVEN."

Type 125G Phantom Antenna Resistance.....$32.00
Dimensions 10¾" x 7⅝" x 5½". Weight 7 lbs.
Code Word "REBEL."



SLIDE WIRE BRIDGE
Type 130

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

Type 130 Slide Wire Bridge.....$18.00

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

Code Word "SATYR."

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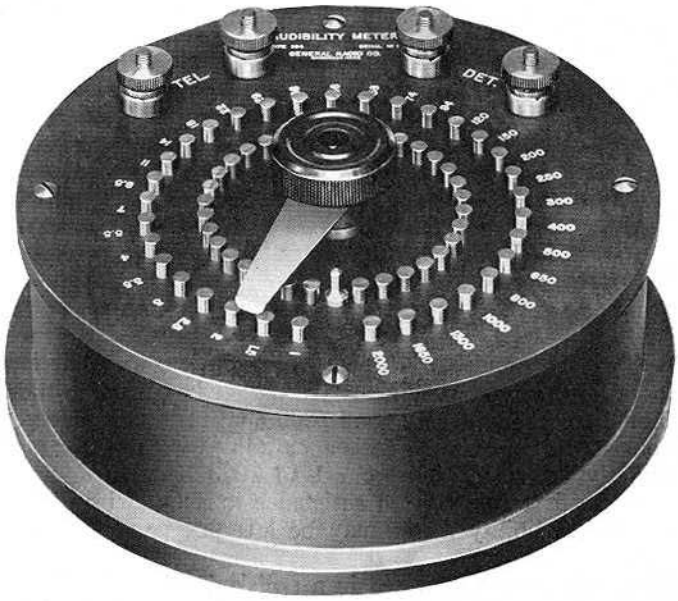
CAMBRIDGE, MASSACHUSETTS

BULLETIN 203 **NOVEMBER 1920**



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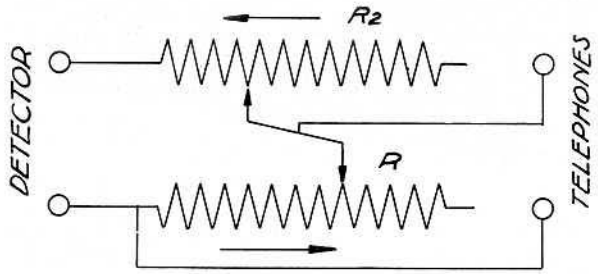

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The resistor is made in two sizes, Type 125A of 4 units of 4 ohms each, and Type 125 G of 2 units of 2 ohms each. The separate units of Type 125A have a carrying capacity of 5 amperes and those of Type 125G 15 amperes. It is possible to connect these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

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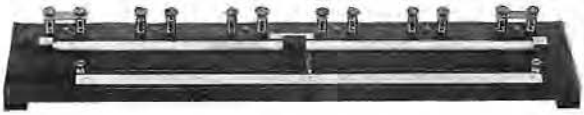

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[This Bulletin replaces Bulletin 202]

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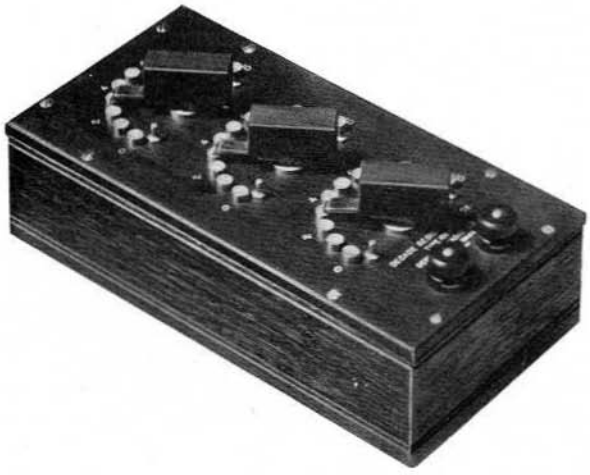
CAMBRIDGE, MASSACHUSETTS

BULLETIN 204 **DECEMBER 1920**

STANDARDS OF RESISTANCE AND DECADE RESISTANCE BOXES



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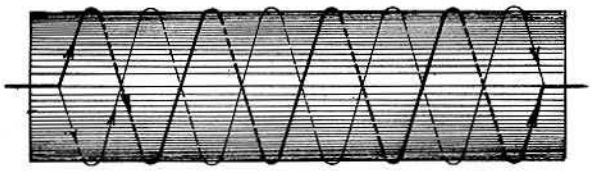

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For general laboratory use the most convenient resistance arrangement is that of decade units. By such a method it is possible to get nearly any value of resistance desired. Such units are compact and rugged. With the use of multiple-leaf contact brushes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

travel, thereby preventing the cutting of grooves in the contact studs, the dial method of mounting decade resistance units is fast replacing the older and less satisfactory plug method of connection. This newer method eliminates the inconvenience of the shifting of plugs, and also their possible loss.

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

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

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

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

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

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

STANDARDS OF RESISTANCE
Type 133

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

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

Dimensions 3″ d. x 2¼″. Weight 11 oz.

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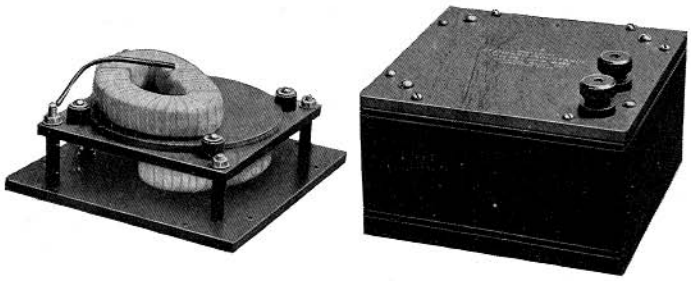
GENERAL RADIO COMPANY

MANUFACTURERS OF
HIGH GRADE RADIO LABORATORY APPARATUS
CAMBRIDGE, MASSACHUSETTS

BULLETIN 301 **JUNE 1920**



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 prevent the possibility of this outside field 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.

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

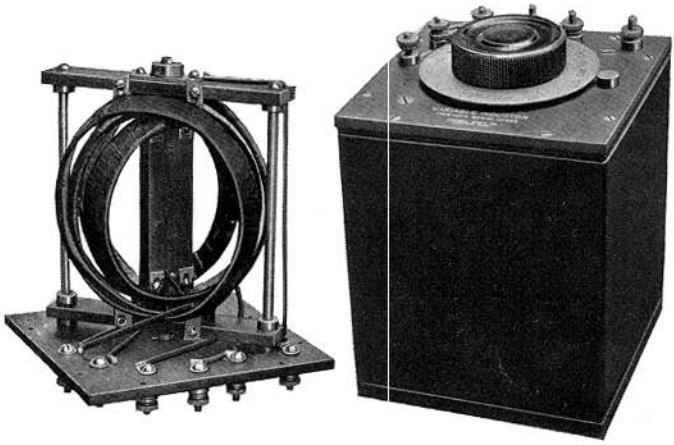
Dimensions 6″ x 6″ x 4″. Weight 2¾ lbs.

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 cur-



rents 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 and 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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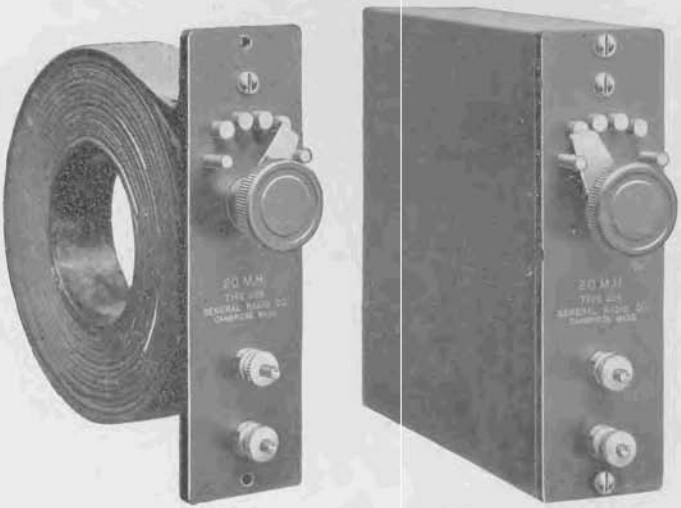
GENERAL RADIO COMPANY

MANUFACTURERS OF
HIGH GRADE RADIO LABORATORY APPARATUS
CAMBRIDGE, MASSACHUSETTS

BULLETIN 302 **AUGUST 1920**



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, 2 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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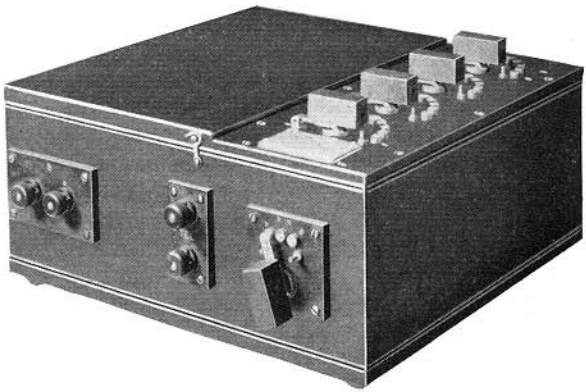
GENERAL RADIO COMPANY

MANUFACTURERS OF

HIGH GRADE RADIO LABORATORY APPARATUS

CAMBRIDGE, MASSACHUSETTS

BULLETIN 401 **MARCH 1920**



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 701. 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.

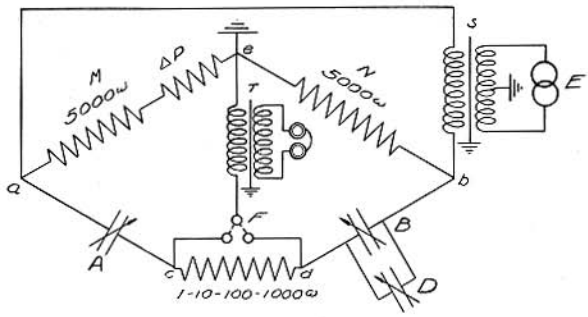
The bridge circuit consists of the two ratio arms M and N, and the arms A and B in which the standard and the unknown condensers are placed. The junction point of the two ratio arms is

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 in 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"

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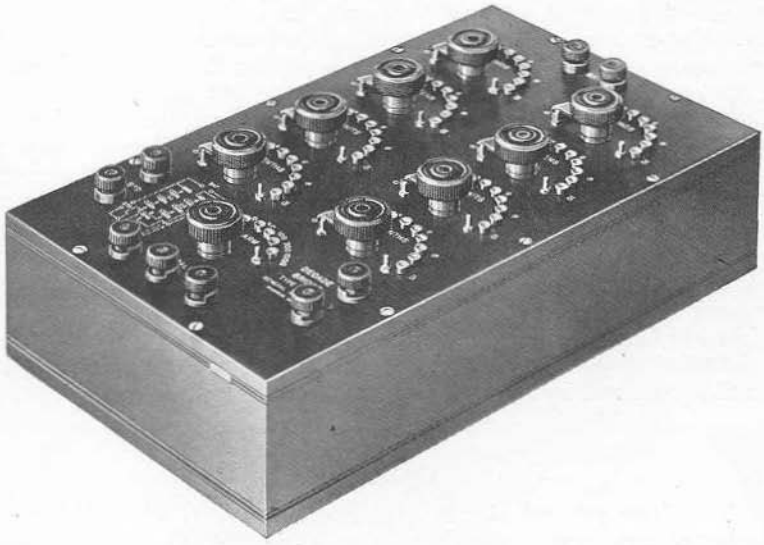
GENERAL RADIO COMPANY

MANUFACTURERS OF

HIGH GRADE RADIO LABORATORY APPARATUS

CAMBRIDGE, MASSACHUSETTS

BULLETIN 402 **AUGUST 1920**



DECADE BRIDGE
Type 193
Description

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

The general arrangement of this bridge consists of three resistance arms, two of which are four dial decades each having a range of from 0.1 ohm to 1111 ohms. The third arm is a single dial having resistance combinations of 1-3-10-30-100-300 and 1000 ohms. In order to adapt this bridge for use with frequencies up to 10,000 cycles all resistance units are wound non-inductively and have very low distributed capacitance. This is accomplished by using the Aryton-Perry Method of winding described in our Bulletin No. 201.

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

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

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

Operation

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

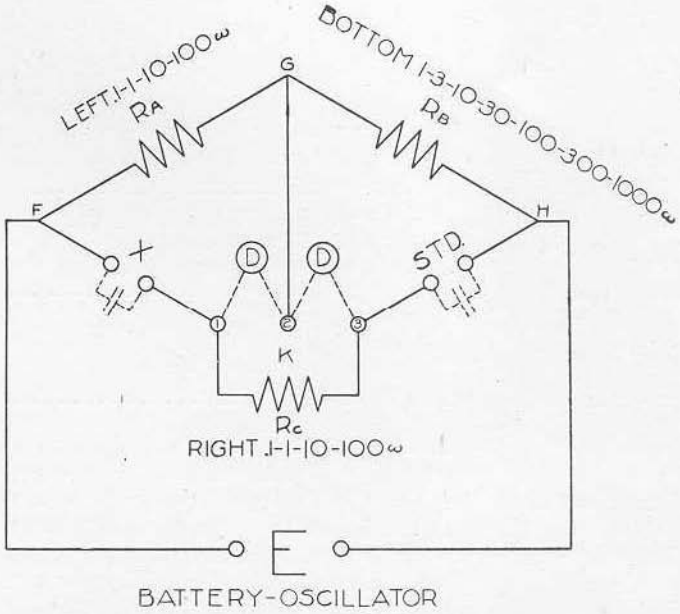
The power source supplied to the bridge is connected to the binding posts marked BAT. For direct current resistance measurements this source is one or two cells of a battery, while for capacitance and inductance measurements an alternating current source must be used. The alternating current should be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

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

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

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

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



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

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

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

Uses

The Type 193 Decade Bridge is designed for general laboratory use. For direct current measurements its principal use is as a Wheatstone bridge. The connections are such, however, that the different arms may be used independently as standard decade resistance units. When used as an impedance bridge the range for capacitance measurements is from 0.003 to several microfarads, and for inductance measurements from about 20 microhenries to several henrys. When making measurements of small capacitances or large inductances the sensitivity of the bridge may be increased by using in the detector circuit a telephone transformer, such as the General Radio Co. Type 166.

The high impedance side, which is marked SEC, is connected across the proper GALV binding posts and the telephone receivers connected across the low impedance side. Since all of the resistance units are wound non-inductively and to have very low distributed capacitance they are adapted for use at radio frequencies.

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

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

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

Western Electric Receivers (Type 1002A)..... $13.00

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GENERAL RADIO COMPANY

MANUFACTURERS OF

HIGH GRADE RADIO LABORATORY APPARATUS

CAMBRIDGE, MASSACHUSETTS

BULLETIN 403 **DECEMBER 1920**

DECADE BRIDGE
Type 193
Description

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

The general arrangement of this bridge consists of three resistance arms, two of which are four dial decades each having a range of from 0.1 ohm to 1111 ohms. The third arm is a single dial having resistance combinations of 1-3-10-30-100-300 and 1000 ohms. In order to adapt this bridge for use with frequencies up to 10,000 cycles all resistance units are wound non-inductively and have very low distributed capacitance. This is accomplished by using the Ayrton-Perry Method of winding described in our Bulletin No. 204.

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

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

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

Operation

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

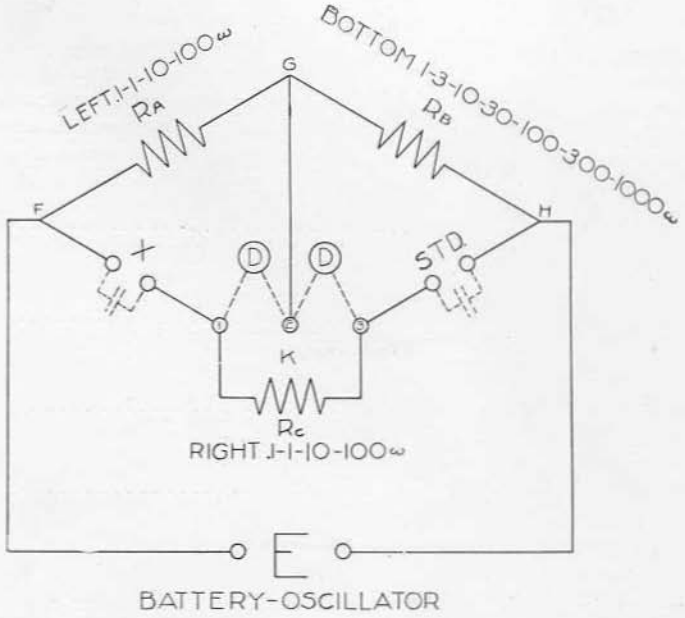
The power source supplied to the bridge is connected to the binding posts marked BAT. For direct current resistance measurements this source is one or two cells of a battery, while for capacitance and inductance measurements an alternating current source must be used. The alternating current should be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

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

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

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

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



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

$$\text{Inductance measurements } Lx = \frac{R_A}{R_B} . Ls$$

$$\text{Capacitance measurements } Cx = \frac{R_B}{R_A} . Cs$$

Uses

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

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

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

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

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

Western Electric Receivers (Type 1002A) $15.00

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, and Miscellaneous Apparatus.

[This Bulletin replaces Bulletin 402]

GENERAL RADIO COMPANY

MANUFACTURERS OF

HIGH GRADE RADIO LABORATORY APPARATUS

CAMBRIDGE, MASSACHUSETTS

BULLETIN 501 **JUNE 1920**

HOT WIRE METER
Type 170

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

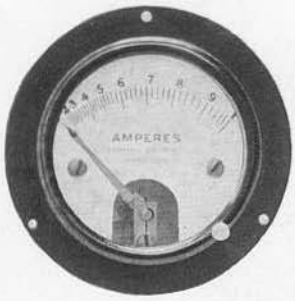
tensively in wavemeters and similar oscillating circuits for determining the resonance point. The Type 170 meters have found a wide use outside of the radio field. They are used as transfer instruments in generator testing and similar work.

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

The type of multiplying action is such that a more uniform scale is obtained than with many hot wire meters. The bearings which support the steel shaft are the best grade jewel sapphire. These meters have been corrected for temperature so that there is very little shift of zero. Any necessary correction may be made by adjusting a knurled screw. This type of instrument is equally accurate on direct or alternating current of any frequency.

These instruments are made in two general sizes. Type 127 is the smaller, or three-inch size, and is made in three types, portable, front-of-board mounting and flush mounting. Type 170 is the large size and is made only in the portable type.

The Type 127 front-of-board and flush mounting meters are mounted in metal cases finished in black japan. The Type 127 portable meters are mounted in moulded bakelite cases. The binding posts are finished in polished nickel. In mounting the flush type of meter an opening in the panel 2⅝" in diameter should be provided. In mounting the front-of-board type allowance should be made for a case 3" in diameter. The Type 170 meters are mounted in polished walnut cases and are fitted with insulated binding posts.



Type 127

Range	Code Word	Case	Price
100 Milli-Amps.	MAYOR	Front of Board	$15.00
¼ amp.	MADAM	Front of Board	11.00
½ amp.	MAJOR	Front of Board	10.00
1 amp.	MANOR	Front of Board	10.00
2 amps.	MARRY	Front of Board	10.00
3 amps.	MASON	Front of Board	10.00
5 amps.	MATIN	Front of Board	10.00
10 amps.	MAXIM	Front of Board	10.00
Galvanometer	MAGIC	Front of Board	9.00

Dimensions 3″ d. x 1½″. Weight 9 oz.

100 Milli-Amps.	MEDAL	Flash Mounting	$15.00
¼ amp.	MERCY	Flush Mounting	11.00
½ amp.	MERIT	Flush Mounting	10.00
1 amp.	MERRY	Flush Mounting	10.00
2 amps.	METAL	Flush Mounting	10.00
3 amps.	MIMIC	Flush Mounting	10.00
5 amps.	MINIM	Flush Mounting	10.00
10 amps.	MINNY	Flush Mounting	10.00
Galvanometer	MITER	Flush Mounting	9.00

Dimensions 3″ x 1½″. Weight 9½ oz.

100 Milli-Amps.	MUGGY	Portable	$16.00
¼ amp.	MOCHA	Portable	12.00
½ amp.	MOGUL	Portable	11.00
1 amp.	MOLAR	Portable	11.00
2 amps.	MONAD	Portable	11.00
3 amps.	MORAL	Portable	11.00
5 amps.	MUMMY	Portable	11.00
10 amps.	MUSTY	Portable	11.00
Galvanometer	MOTTO	Portable	10.00

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

Type 170

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

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

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.

GENERAL RADIO COMPANY

MANUFACTURERS OF
HIGH GRADE RADIO LABORATORY APPARATUS
CAMBRIDGE, MASSACHUSETTS

BULLETIN 502 **DECEMBER 1920**

HOT WIRE METER
Type 170

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

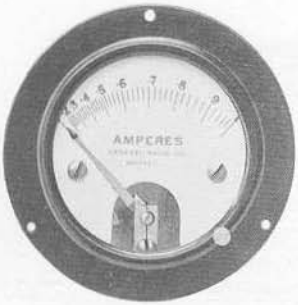
oscillating circuits for determining the resonance point. The Type 127 meters are used extensively for measuring the radiation, filament and plate currents in experimental continuous wave transmitting stations. The Type 170 meters have found a wide use outside of the radio field. They are used as transfer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

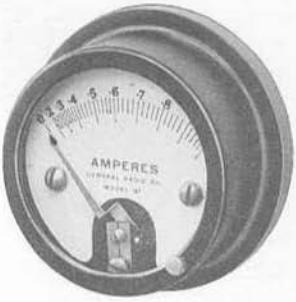
The expanding strip in these meters is of thin platinum, so as to prevent oxidation. It is so proportioned that it works at a low temperature and is of low resistance. These are two highly desirable features, since the former permits reasonable overloading without burning out, and the latter minimizes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

The type of multiplying action is such that a more uniform scale is obtained than with many hot wire meters. These meters have been corrected for temperature so that there is very little shift of zero. Any necessary correction may be made by adjusting a knurled screw. This type of instrument is equally accurate on direct or alternating current of any frequency.

These instruments are made in two general sizes. Type 127 is the smaller, or three-inch size, and is made in three types, portable, front-of-board mounting and flush mounting. Type 170 is the large size and is made only in the portable type.

The Type 127 flush mounting meters are mounted in metal cases finished in black japan, while the front-of-board and portable types have cases of moulded bakelite. In mounting the flush type of meter an opening in the panel 2⅝" in diameter should be provided. In mounting the front-of-board type allowance should be made for a case 3" in diameter. The Type 170 meters are mounted in polished walnut cases and are fitted with insulated binding posts.





TYPE 127A

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

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

TYPE 127B

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

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

TYPE 127C

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

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

TYPE 170

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

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

POINTER GALVANOMETER
Type 189

This is a portable instrument of the same general size as the Type 170 hot wire ammeter and is designed for use with direct currents of small magnitude. It is of the D'Arsonval type, has a double suspension and is well damped. It is made with a resistance of either 10 or 100 ohms and with scales having either zero left or zero center. The 100 ohm type requires approximately 25 microamperes for a full scale deflection—50 divisions from center to either side—while the 10 ohm type requires approximately 75 microamperes. The zero left instruments require twice these currents for full scale deflections of 100 divisions. When used with our Type 134 Thermo Couple, these galvanometers may be used to measure currents too small to give satisfactory readings on a 100 milliampere hot wire ammeter.

Price, any type $32.00
Size 4¾" x 5" x 3½". Weight 2½ lbs.

Type 134 Thermo Couple $6.00
Size 2½" x 1¼" x 2". Weight 4 oz.

While the meters of our own manufacture are limited to our Types 127 and 170 hot wire ammeters and our Type 189 D'Arsonval portable galvanometer, we can also supply Weston meters of all types.

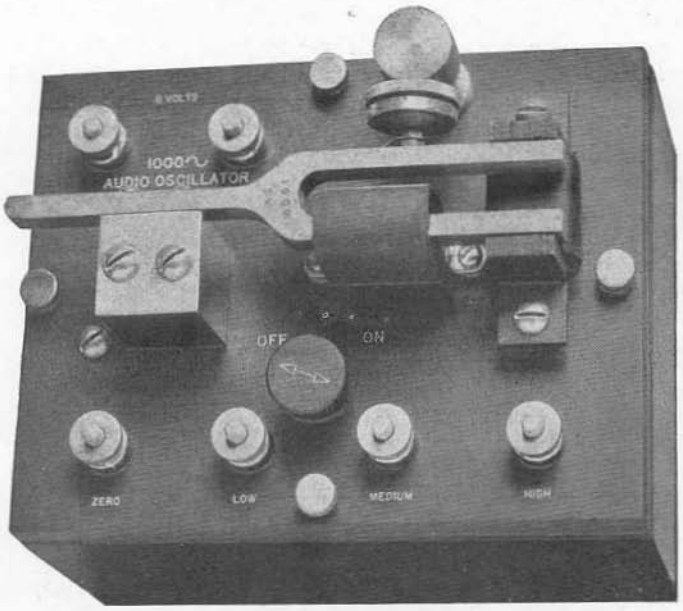
All prices in this bulletin are strictly net, subject to change without notice, F. O. B. Cambridge, Mass. Cash should accompany orders from persons or firms with whom we have not already opened accounts. Unless otherwise instructed we shall use our own judgment regarding method of shipment.

[This Bulletin replaces Bulletin 501]

GENERAL RADIO COMPANY

MANUFACTURERS OF
HIGH GRADE RADIO LABORATORY APPARATUS
CAMBRIDGE, MASSACHUSETTS

BULLETIN 701 **FEBRUARY 1920**



AUDIO OSCILLATOR
Type 213

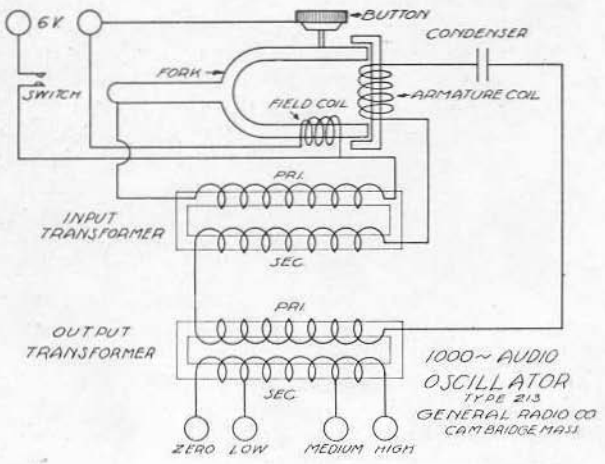
The precision of most alternating current bridge measurements is in no small measure dependent on the source of power supplied to the bridge. The wave form should be strictly free from harmonics. Where a balance is indicated by means of the null method with a telephone receiver, the presence of harmonics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

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

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

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

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



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

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

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

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

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

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

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

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

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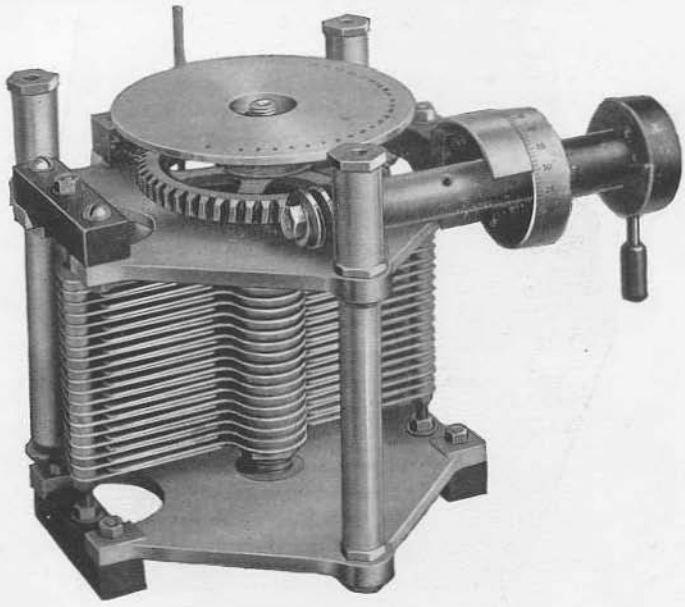
GENERAL RADIO COMPANY

MANUFACTURERS OF

HIGH GRADE RADIO LABORATORY APPARATUS

CAMBRIDGE, MASSACHUSETTS

BULLETIN 702 **AUGUST 1920**



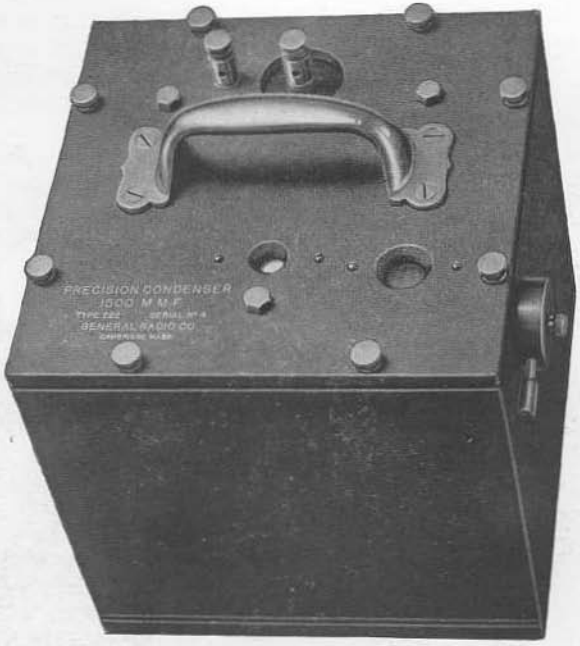
PRECISION CONDENSER
Type 222

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

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

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

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



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

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

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

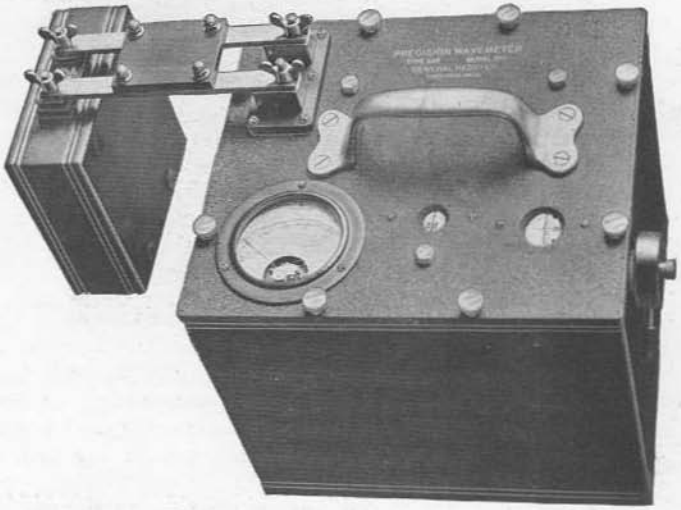
The case is of polished mahogany and is lined with a copper shield grounded to the rotary plates. A ¼ inch aluminum plate finished in a permanent crystalline black forms the condenser top. Other metal parts are finished in polished nickel. The top is fitted with a carrying handle. In order that the condenser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

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

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

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

Code Word "COPAL"



PRECISION WAVEMETER
Type 224

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

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

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

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

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

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

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

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

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

Type 224 Precision Wavemeter.....$220.00

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

Code Word "WAGER"

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

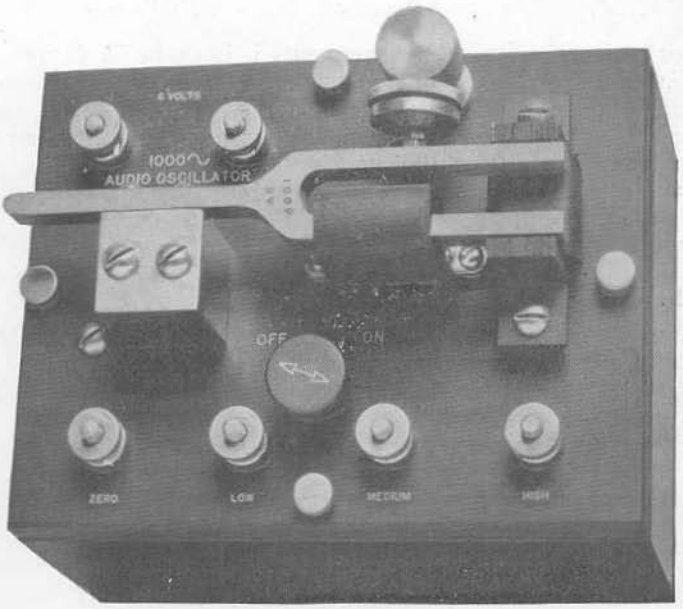
GENERAL RADIO COMPANY

MANUFACTURERS OF

HIGH GRADE RADIO LABORATORY APPARATUS

CAMBRIDGE, MASSACHUSETTS

BULLETIN 703 **NOVEMBER 1920**



AUDIO OSCILLATOR
Type 213

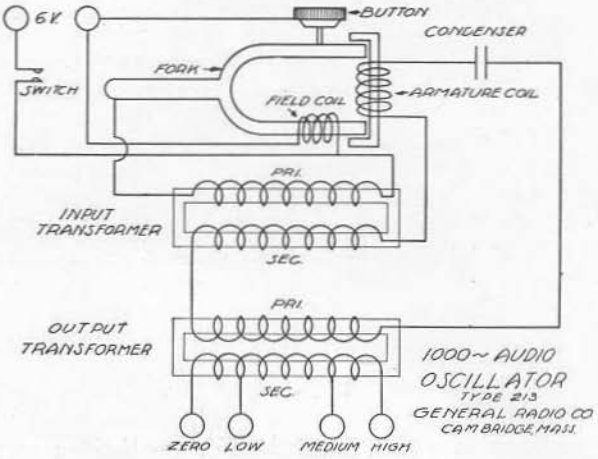
The precision of most alternating current bridge measurements is in no small measure dependent on the source of power supplied to the bridge. The wave form should be practically free from harmonics. Where a balance is indicated by means of the null method with a telephone receiver, the presence of harmonics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

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

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

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

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



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

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

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

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

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

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

Type 213 Audio Oscillator.....$32.00

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

Code Word "AUGER."

WESTERN ELECTRIC HEAD PHONES
Type 1002-A

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

Price complete with cord.....$15.00

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

[This Bulletin replaces Bulletin 701]

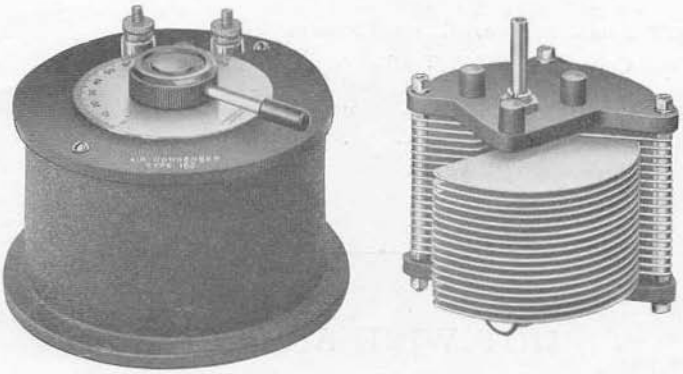
GENERAL RADIO COMPANY

MANUFACTURERS OF

HIGH GRADE RADIO LABORATORY APPARATUS

CAMBRIDGE, MASSACHUSETTS

BULLETIN 901 **JANUARY 1920**



VARIABLE AIR CONDENSER

TYPE 182

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

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

A small extension handle is provided for accurate adjustment.

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

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

HOT WIRE AMMETERS

TYPE 127

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

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

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

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

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

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

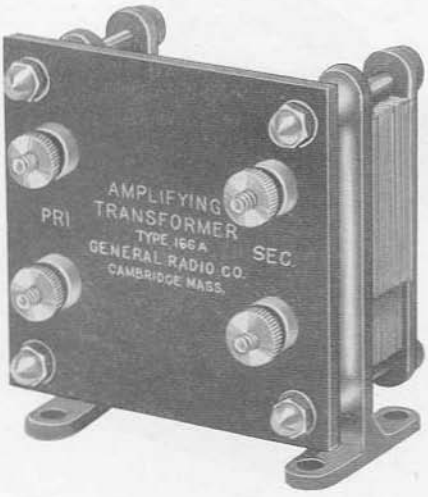
Dimensions 3 in. d. x 1½ in. high. Weight 9 oz.

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

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

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

Price $9.00



AMPLIFYING TRANSFORMER

TYPE 166A

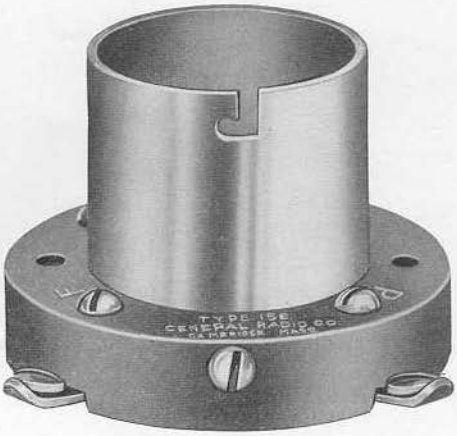
There are many points which must be considered in the design of a satisfactory amplifying transformer. The primary must be capable of receiving the maximum amount of energy while the secondary must deliver this energy undistorted in wave-form, and at the correct potential to the grid circuit of the amplifying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

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

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

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

Supports for mounting 75



TUBE SOCKET

TYPE 156

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

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

MARCONI VACUUM TUBES

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

Price each $7.00

WESTERN ELECTRIC HEAD PHONES

TYPE 1002A

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

Price, complete with cord $12.50

10 STEP INDUCTOR

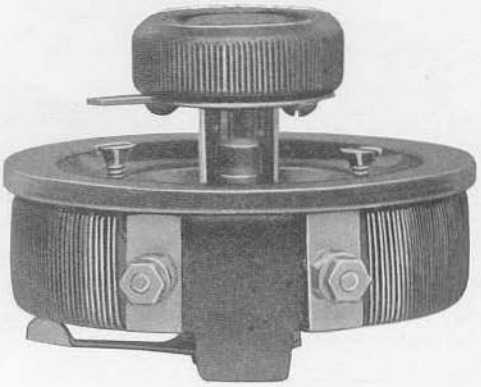
TYPE 111

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

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

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

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



RHEOSTAT

TYPE 214

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

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

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

THE GR BUZZER

TYPE 178

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

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

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

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

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

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

GENERAL RADIO COMPANY

MANUFACTURERS OF
HIGH GRADE RADIO LABORATORY APPARATUS
CAMBRIDGE, MASSACHUSETTS

BULLETIN 902 **MAY 1920**

DETECTOR SET AND AMPLIFIERS

VACUUM TUBE DETECTOR
Type 211

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

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

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

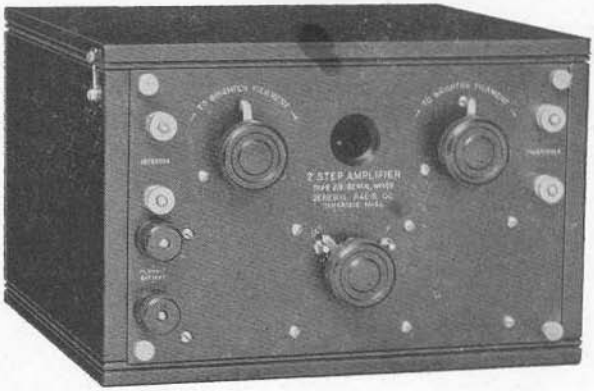
Special attention is called to the fact that a valuable grid condenser and a grid leak are included in this set. They provide a very convenient method of controlling the operation of the tube. This is very essential if the maximum results are to be obtained from the set. A peep hole in the panel is provided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

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

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

VACUUM TUBE AMPLIFIERS

Types 206 and 215



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

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

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

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

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

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

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

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GENERAL RADIO COMPANY

MANUFACTURERS OF
HIGH GRADE RADIO LABORATORY APPARATUS
CAMBRIDGE, MASSACHUSETTS

BULLETIN 903 **AUGUST 1920**

RATIO ARM BOX
Type 210

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

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

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

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

Code Word "RABID"

UNIVERSAL GALVANOMETER SHUNT
Type 229

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

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

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

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

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

Code Word "GAVOT"

WESTERN ELECTRIC HEAD PHONES
Type 1002-A

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

Price complete with cord.....$13.00

TELEPHONE TRANSFORMER
Type 166

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

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

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

Type 166 Telephone Transformer.....$9.00

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

Code Word "TOPIC"

MODULATION TRANSFORMER
Type 166M

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

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

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

AMPLIFYING TRANSFORMER
Type 166A

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

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

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

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

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

Supports for mounting..... .75

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

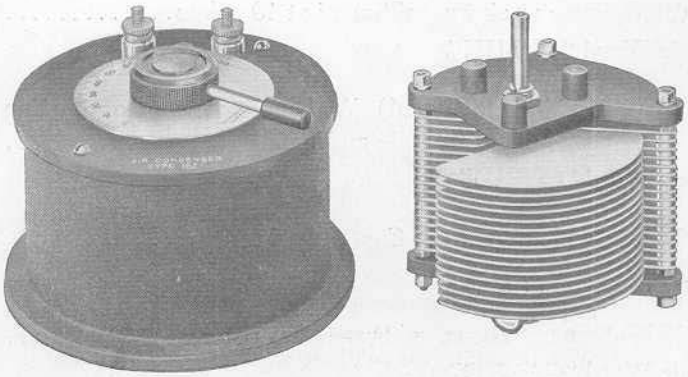
GENERAL RADIO COMPANY

MANUFACTURERS OF

HIGH GRADE RADIO LABORATORY APPARATUS

CAMBRIDGE, MASSACHUSETTS

BULLETIN 904 **DECEMBER, 1920**



VARIABLE AIR CONDENSER
TYPE 182

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

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

A small extension handle is provided for accurate adjustment.

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

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

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

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

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

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

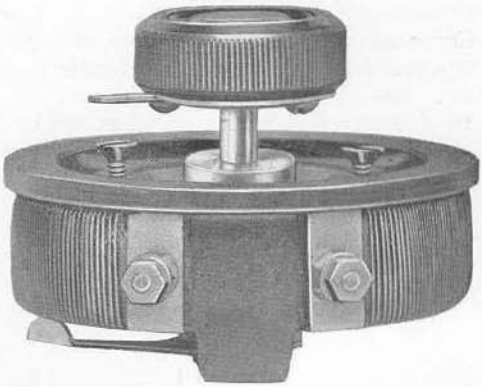
Type 182G (182E Unmounted) Without case, top, or binding posts, but with scale and handle $9.70
Code Word "CAPER"

THE GR BUZZER
TYPE 178

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

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

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



RHEOSTAT
TYPE 214

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

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

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

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

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

WESTERN ELECTRIC HEAD PHONES
TYPE 1002A

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

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

VACUUM TUBES

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

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

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

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

HOT WIRE AMMETERS
TYPE 127

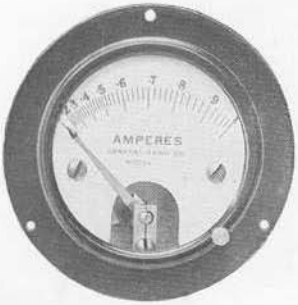
In spark transmitting stations a radiation ammeter is a great convenience; in continuous wave stations it is almost a necessity. It is also desirable to know the filament current of vacuum tubes. This is particularly true of transmitting tubes. The charging rate of storage batteries should be known.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

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

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

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

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



TYPE 127A

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

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

TYPE 127B

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

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

TYPE 127C

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

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

AMPLIFYING TRANSFORMER
TYPE 166A

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

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

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

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

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

Supports for mounting.....$ .75

MODULATION TRANSFORMER
TYPE 166M

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

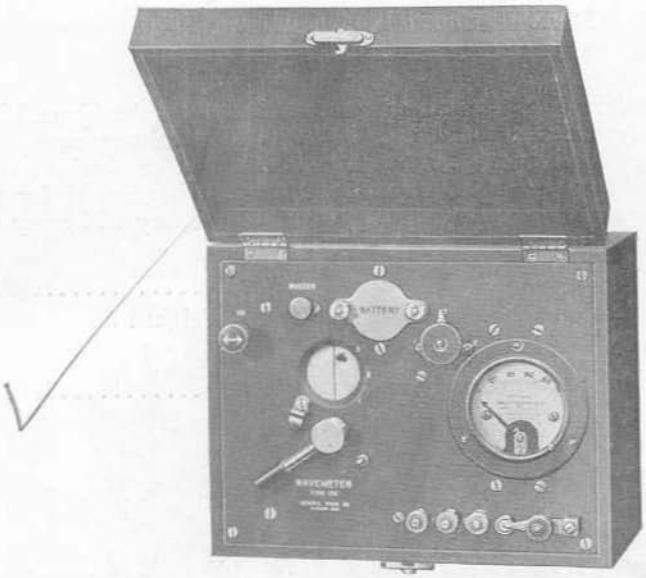
Type 166M Modulation Transformer $7.00
Dimensions 2¾ in. x 2½ in. x 2¼ in. Weight 1 lb.
Code Word "TAPER"

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

TUBE SOCKET
TYPE 156

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

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



DIRECT READING WAVEMETER
TYPE 174

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

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

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

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

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

[This Bulletin replaces Bulletin 901]

GENERAL RADIO COMPANY

MANUFACTURERS OF

HIGH GRADE RADIO LABORATORY APPARATUS

CAMBRIDGE, MASSACHUSETTS

BULLETIN 905 **DECEMBER 1920**

RATIO ARM BOX
Type 210

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

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

Type 210 Ratio Arm Box $36.00

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

Code Word "RABID"

UNIVERSAL GALVANOMETER SHUNT
Type 229

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

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

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

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

WESTERN ELECTRIC HEAD PHONES
Type 1002-A

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

Price complete with cord $15.00

TELEPHONE TRANSFORMER
Type 166

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

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

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

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

MODULATION TRANSFORMER
Type 166M

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

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

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

AMPLIFYING TRANSFORMER
Type 166A

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

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

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

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

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

Supports for mounting $0.75

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, and Miscellaneous Apparatus.

[This Bulletin replaces Bulletin 903]

GENERAL RADIO COMPANY

MANUFACTURERS OF
HIGH GRADE RADIO LABORATORY APPARATUS
CAMBRIDGE, MASSACHUSETTS

BULLETIN 906 **DECEMBER 1920**

DETECTOR SET AND AMPLIFIERS

VACUUM TUBE DETECTOR
Type 211

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

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

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

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

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

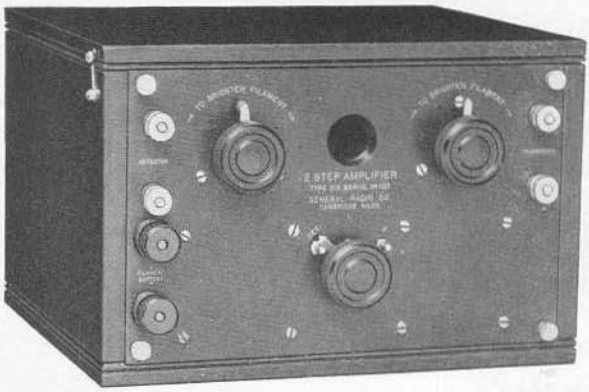
Type 211 Detector Set $32.00

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

Code Word "DETER."

VACUUM TUBE AMPLIFIERS

Types 206 and 215



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

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

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

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

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

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

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

Radiotron U. V. 201 Vacuum Tubes $6.50

Navy Standard Type Dry Batteries—22 volts $3.50

WESTERN ELECTRIC HEAD PHONES

Type 1002A

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

Price, complete with cord $15.00

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