September 7th, 1929 15 CENTS

RADIO WORLD

REG. U.S. PAT. OFF.

The First and Only National Radio Weekly

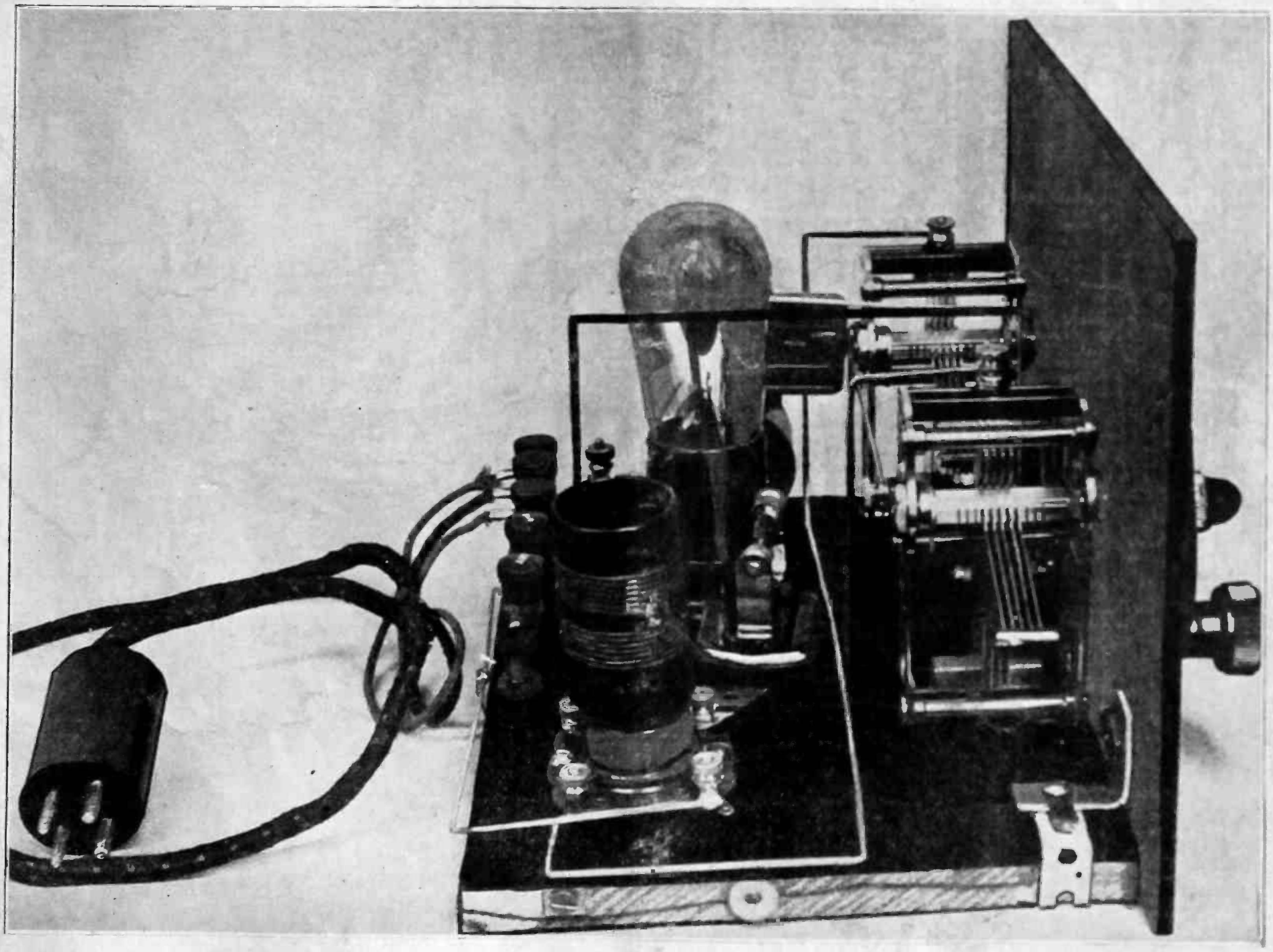
389th Consecutive Issue—EIGHTH YEAR

LIST OF STATIONS BY CALL LETTERS

Reactivation of Tubes Explained

Tuning the HB Compact

FOREIGN STATIONS ON SHORT-WAVE ADAPTER!



See Article on this Adapter on pages 3 and 4.

New A C High Mu Tube Analysis

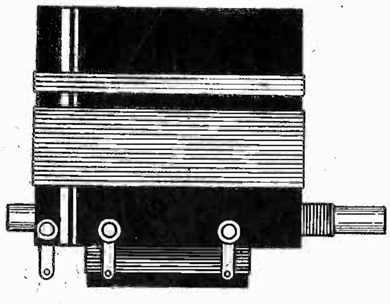
Extension of the Range of Meters

How to Use Phonograph Pick-ups

Ten Questions You Ought to Answer Easily

A NEW IDEA IN COILS!

The Bernard Tuner Works Screen Grid Tubes Up to the Hilt!

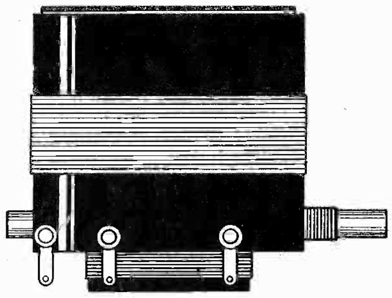


Cat. No. BT5A—$2.50
FOR .0005 MFD. CONDENSERS
Bernard Tuner for antenna coupling, the primary being fixed and the secondary tuned. This coil is used as input to the first screen grid radio frequency tube. The double-action tuning method invented by Herman Bernard is employed. Adjust an equalizing condenser across the tuning condenser so that exactly the same dial settings prevail through all circuits. This equalizer, 90 mmfd., once set, is left thus.
Cat. No. BT3A for .00035 mfd. $2.55

FOR the first time in radio a coil has been designed that permits working the screen grid tube up to the enormous amplification level that theory long promised but practice long denied.

The secret lies in tuning the plate circuit of the screen grid tube, and still covering the entire broadcast band. Herman Bernard, noted radio engineer, invented the solution—a tuned coil consisting of a fixed and a rotating winding in series, the moving coil turned by the same dial that turns the tuning condenser. An insulated link physically unites condenser shaft and moving coil. Thus when the condenser plates are entirely in mesh the moving coil is set for maximum inductance. that is, it aids the other part of the tuned winding. As the condenser is turned to lower capacity setting the moving coil aids less and less, until at the middle of the dial it acts as if fixed. From then on the moving coil bucks the fixed winding, greatly reducing the total effective inductance, and thus nullifying the effect of the high starting capacity.

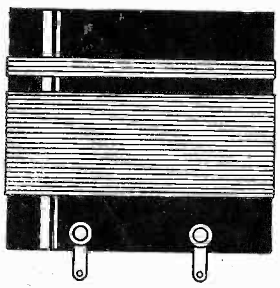
The Bernard Tuner is a two-winding coil for interstage coupling, working out of a screen grid tube, 222 or 224, and into any type tube. The tuned primary has coupled to it a still larger inductance, on separate inside form, for step-up, thus greatly increasing an already enormous amplification! This is Cat. No. BT5B for .0005 mfd., BT3B for .00035 mfd. Use BT5A or BT3A for antenna coupler, tuning the secondary, with an equalizing condenser across the antenna tuning condenser, so that the high minimum capacity of the tube's output will be duplicated at the input.



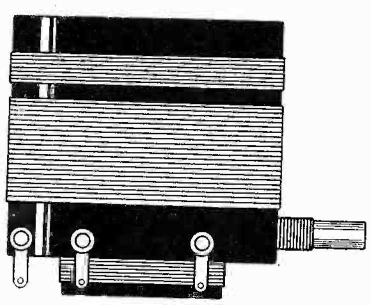
Cat. No. BT5B—$2.50
FOR .0005 MFD. CONDENSERS
Bernard Tuner for working out of a screen grid tube, consists of a rotary coil in series with a fixed coil, the two constituting a tuned primary, for tuning the combined rotary and fixed windings to exceed the broadcast band of wavelengths. The condenser shaft and rotary coil shaft are physically coupled so one motion turns both. Develops the highest possible amplification from the screen grid tube.
Cat. BT3A for .00035 mfd.............$2.55

The Diamond Pair

Since 1925 the Diamond of the Air has been an outstanding circuit. It has undergone few changes. When power tubes and screen grid tubes appeared these were included. When AC operation became practical, the model was described for such use. Whether battery-operated or AC-operated, the Diamond of the Air is a dependable and satisfactory circuit. It uses a screen grid RF stage, tickled detector and two stages of transformer coupled audio. The same coils are used for both models, battery or AC. The secondaries are tuned. They are matched with fine precision, to permit ganged tuning.



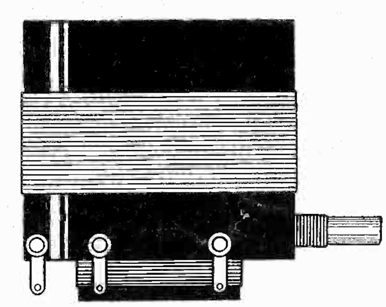
Cat. No. RF5—$0.75
FOR .0005 MFD. CONDENSER
Antenna coil for any standard circuit, and one of the two coils constituting the Diamond Pair. The secondary is carefully wound to match the inductance of the companion coil's secondary, so equality of tuning prevails.
Cat. No. RF3 for .00035...$0.80



Cat. No. SGT5—$1.25
FOR .0005 MFD. CONDENSER
Interstage 3-circuit coil for any hookup where an untuned primary is in the plate circuit of a screen grid tube. This primary has a large impedance (generous number of turns), so as to afford good amplification. Used in the Diamond of the Air.
SGT3 for .00035 mfd..............$1.30

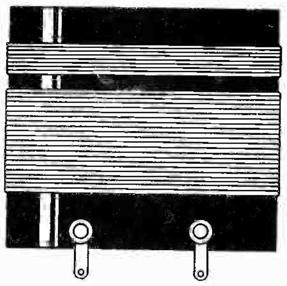
The Diamond Pair of coils for .0005 mfd. tuning are Cat. Nos. RF5 and SGT5. A circuit of excellent stability, extremely high selectivity and good sensitivity, the Diamond of the Air should be built with coils that permit full capitalization of the virtues of the circuit. Not only is the number of turns correct for this circuit on each coil, but the spacing between aperiodic primary and tuned secondary is exactly right. Note that the 3-circuit coil SGT5 (or SGT3) has a high impedance primary. This means good amplification from the screen grid tube, obtained in a manner that guarantees selectivity attainment.

ANTENNA COUPLER



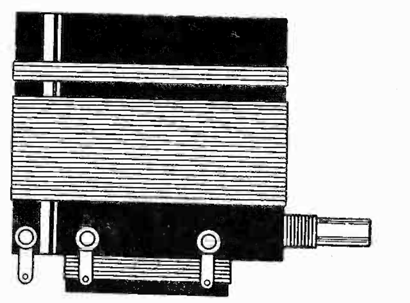
Cat. No. VA5—$1.10
FOR .0005 MFD. CONDENSER
Moving primary and fixed secondary, for antenna coupling, adjustable from a knob at the front panel, thus providing volume control.
Cat. No. VA3 for .00035 mfd..........$1.15

SG TRANSFORMER



Cat. No. SGS5—$0.75
FOR .0005 MFD. CONDENSER
Interstage radio frequency transformer. to work out of a screen grid tube, where the generous-sized primary is in the untuned plate circuit.
Cat. No. SGS3 for .00035 mfd........$0.80

STANDARD TUNER



Cat. No. T5—$1.25
FOR .0005 MFD. CONDENSER
Standard three-circuit tuner, for antenna stage, or interstage coupling where primary is in the plate circuit of any tube except a screen grid. Provides abundant selectivity and gives smooth tickler action.
Cat. T3 for .00035 mfd................$1.30

SCREEN GRID COIL COMPANY, 143 West 45th St., New York, N. Y.
Just East of Broadway

Enclosed please find $.............. for which please ship at once, parcel post prepaid, the following coils:

Quantity Cat. No. Price	Quantity Cat. No. Price	Quantity Cat. No. Price	Quantity Cat. No. Price
☐ BT5A@$2.50	☐ RF5@$0.75	☐ VA5@$1.10	☐ SGSF@$0.75
☐ BT3A@$2.55	☐ RF3@$0.80	☐ VA3@$1.15	☐ SGS3@$0.80
☐ BT5B@$2.50	☐ SGT5@$1.25	☐ T5@$1.25	☐ FL1@$0.35
☐ BT3B@$2.55	☐ SGT3@$1.30	☐ T3@$1.30	☐ EQ80@$0.35

NAME ....

ADDRESS ....

CITY.............................. STATE..............................

5-DAY MONEY-BACK GUARANTEE!

Insulated Link

A flexible coupling device to unite two independent ¼" shafts for single dial operation of a tuning condenser and a Bernard Tuner. If the condenser has shaft protruding from the rear then the condenser may be panel mounted and the coil shaft coupled by the link to either extension shaft of the condenser. If the condenser has no shaft protruding at rear, mount the Bernard Tuner on the front panel. It has shaft protruding at rear for coupling by the link to the condenser's front shaft. To make sure of insulated protection do not force the receptacles of the link together when mounting.

FL4..$0.35

Data on Construction

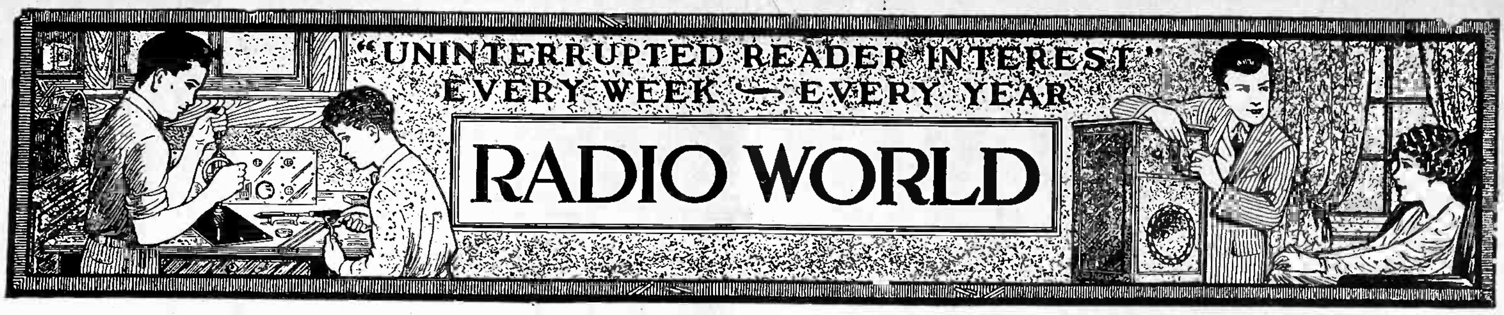
The coils are wound by machine on a bakelite form 2½" wide, and the tuned windings have identical inductance for a given capacity condenser, i. e., .0005 mfd. or .00035 mfd. Full coverage of the wave band is assured. The wire is silk insulated.

All coils with a moving coil have single hole panel mounting fixture. All others have base mounting provision. The coils should be used with connection lugs at bottom, to shorten leads.

Only the Bernard Tuners have a shaft extending from rear. This feature is necessary so that physical coupling to tuning condenser shaft may be accomplished by the insulated link.

[Note: Those desiring the 80 mmfd. equalizing condenser for use with the antenna model Bernard Tuner, BT5A or BT3A, should order EQ80 at $0.35.]

SCREEN GRID COIL COMPANY
143 West 45th Street, New York City



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Latest Circuits and News

EIGHTH YEAR

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I Get Abroad

On My Little Short-Wave Adapter

By John F. Barry

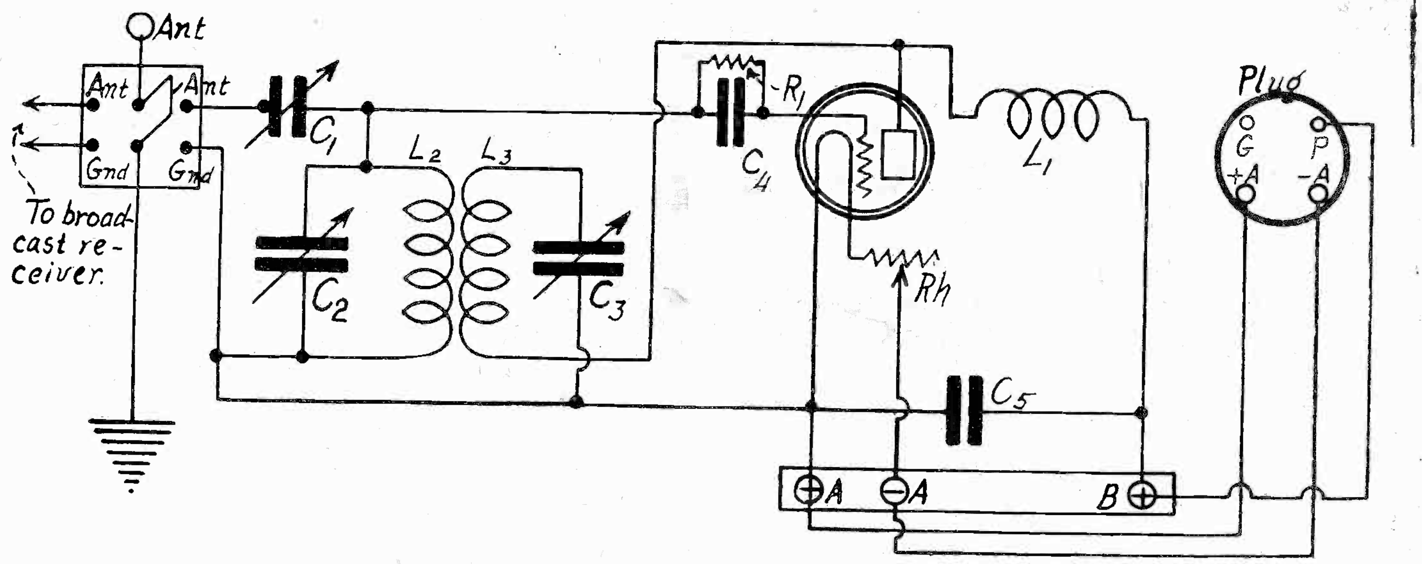

Fig. 1
CIRCUIT DIAGRAM OF BARRY'S ADAPTER

RADIO fans who have built short wave receivers or adapters without any success are skeptical about the claims of others who report consistent reception of remote stations. Indeed, they are more than skeptical; they are convinced that those who report reception of stations on the other side of the earth are endowed with fertile imaginations.

It is, indeed, easy to discount the claims of others after a few failures with replicas of the very receivers upon which the claims are based. It is easier to reach adverse conclusions about the other fellow's claims than to admit superior skill on his part, or a more enduring patience.

Yet it is a fact that while the tribe or skeptics doubt and scoff at claims, there is another tribe of fans that is daily enjoying the thrills that come with the reception of stations located abroad. There is no denying that there is a thrill in hearing an announcer speak in German, Dutch, Spanish, Russian, Chinese, even if the announcements mean nothing except the certainty that they emanate from a remote station. There is no denying that there is a thrill in hearing music played by foreign musicians in their home lands while you yourself are comfortably seated at your own fireside. There is no denying there is a thrill in hearing the sounds of Big Ben tolling the midnight hour while you are eating your dinner in the evening, or in hearing the ticking of a clock in Eindhoven, Holland, many, many ticks ahead of your own parlor clock.

There is a general impression in radio circles that short wave adapters in general are not successful. There are many reasons why this view has gained wide circulation. One is that many adapters put on the market were not up to the standard required for short wave reception. Another is that many good adapters were not adaptable to the great variety of receivers in use. Still another is that many fans did not have the patience to make the adaptation properly, nor to tune properly the short wave combination after the adaptation was properly made.

There is no technical reason why short wave adapters should not work well. That it is so attested by the fact that many who have made adapters and the adaptation to their broadcast receivers have had phenomenal success. One of these fans is the author, who is just a radio experimenter living in White Plains, New York, and who listens to European short wave stations as if they were local broadcasting stations. He brings them in whenever they are on the air and whenever it pleases him to tune them in. Moreover, he does not keep the reception to himself, but he invites his neighbors and friends to share the enjoyment of the entertainments from abroad.

Not only have I proven my claims by local witnesses but I have secured confirmation from several European stations of their reception. Thus I have a letter from Funk-Stunde Aktiengesellschaft, Berlin, Germany, confirming the reception of their 25.5 meter station, another from N. V. Philips' Radio, Eindhoven, Holland, confirming reception of programs from PCJ, on 30.2 meters and still another from World-Radio, London, England, confirming reception of programs from 5SW, Chelmsford, England, 24 meters. Please note that Eindhoven signs itself PCJ, not PCJJ as listed in most short wave directories.

Some one of the skeptical tribe might suggest that I am using

LIST OF PARTS

L1—One 85-millihenry choke coil
L2, L3—One set of short wave coils, as described
C1—One 50 mmfd. midget condenser (about 13 plates)
C2, C3—Two .00014 mfd. variable condensers
C4—One moulded mica condenser, capacity .00015 mfd., with clips
C5—One .001 mfd. condenser
R1—One 10 megohm grid leak
Two cushion type standard sockets
One double pole, double throw switch
One binding post strip with three binding posts
One adapter plug, or plug made of old tube base
One 112A tube
One 7x10 panel
One 7x9 baseboard
Two dials, vernier type

HAS VERIFICATIONS

To Prove He Gets Foreign Stations

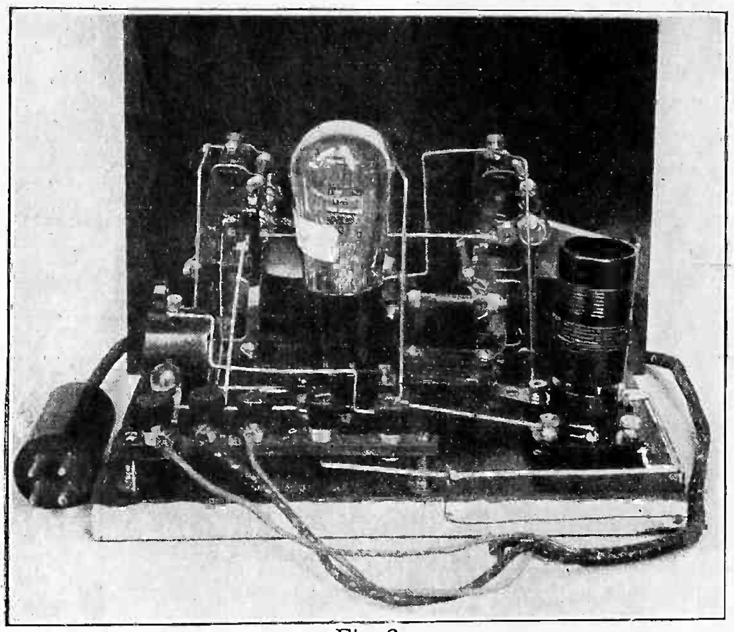

Fig. 2
A VIEW OF THE ADAPTER FROM THE REAR

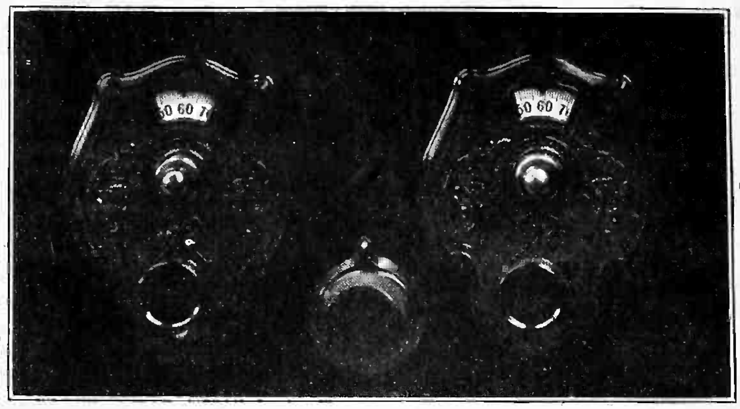

Fig. 3
THE APPEARANCE OF THE FRONT PANEL IF THE 7-INCH HEIGHT IS CUT DOWN, WHICH IS OPTIONAL

an adapter with an extraordinary array of amplifier tubes. But such is not the case. There is only one tube in the adapter, and I plug it into the detector socket of my broadcast receiver, thus using the amplifier in that circuit. As a matter of fact, there is nothing unusual about the circuit diagram of his adapter. The secret, if there be one, is in the use of first class parts, put together in the proper way, and handled by one who has learned how to tune. A glance at the circuit diagram, Fig. 1, will show the simplicity of the adapter.

In the antenna circuit is a double throw, double pole switch by means of which either the broadcast wavelengths or the short wave adapter may be selected, or rather by means of which the antenna may be thrown to one or the other.

Much depends on the antenna for the success of short wave receivers, so it is well to describe the antenna used in my set. It consists of 100 feet of No. 14 solid enameled copper wire erected in the form of an inverted L with the horizontal portion running North and South, the lead-in being taken off at the South end. Naturally, it is well insulated so that no part of the short wave signal is frittered away in insulation leakage. The ground lead goes to the cold water system of the house. That is the type of antenna and ground that can be recommended for almost any radio installation.

Starting with the antenna lead when the switch is thrown to the short wave adapter we first come to a midget condenser C1 which is in series with the antenna and the tuned circuit. This condenser is for the purpose of "shortening" the antenna and to make it suitable for the short waves. It is a thirteen-plate variable condenser.

One side of this condenser connects with the top of the tuned circuit and with the grid leak R1 and stopping condenser C4. The leak has a value of 10 megohms and the condenser .00015 mfd.

The tuned circuit consists of a straight line frequency condenser C2 of .00014 mfd. and a short wave coil L2. The tickler circuit is of the shunt type and consists of the coil L3 and another .00014 mfd. condenser C3. The rotors of both C2 and C3 are grounded, which explains the reason why there is no body capacity effects in the circuit even when critical regeneration is used.

In order to force the radio frequency currents through the tickler a radio frequency choke coil L1 is connected in the plate circuit of the tube. Also, a .001 mfd. by-pass condenser C5 is connected across the output to prevent any radio frequency currents from wandering into parts of the circuit where they don't belong.

Best results are obtained with a 112A tube in the adapter. Any other tube, including a screen grid tube, gave poorer results. A necessary condition for optimum results is that a rheostat be used in the filament circuit of the tube. The rheostat, Rh, is put in the negative leg of the filament circuit and its maximum resistance is 6 ohms. The socket used for the tube is of the cushioned type to minimize mechanical vibration of the elements.

The filament and plate leads of the adapter terminate on a binding post strip marked A plus, A minus and P. This is used for convenience and to provide an anchor for the leads. To this binding post strip are connected the flexible leads to the plug which is inserted into the detector socket of the broadcast receiver. A view of this plug is shown at the right in the drawing with the leads running to proper prongs. The view is taken from above the plug as it would be inserted. Note that the two filament leads are reversed from the usual connection. This happened to be the proper connection for the broadcast amplifier used with this adapter. If the broadcast amplifier is wired in the usual manner these two leads should be reversed. Of course, the essential thing is that plus goes to plus and minus to minus regardless of the manner in which the receiver has been wired. Before connecting the leads to the plug the polarity of the detector socket springs in the broadcast receiver should be tested to avoid any mistake.

The tuning coils L2 and L3 are wound on a small form 1.25 inches in diameter and are provided with a standard tube base prong which fits into a cushion type socket. Thus change of coils from one wavelength range to another is done in a moment.

Batteries should be used both for the filament current and the plate voltage. Eliminators are not recommended. The plate voltage on the tube is 45 volts, supplied, however, through a variable resistance located in the broadcast receiver and not shown in the adapter diagram. A resistance having a maximum value of 50,000 ohms is suggested.

In addition to using batteries not only on the adapter tube but also on the broadcast receiver used in conjunction with it, I strongly recommend individual rheostats on all the tubes used in preference to automatic filament control or fixed ballast resistors.

In order to eliminate all body capacity effects the entire adapter is shielded. The box containing the adapter is lined with phosphor bronze screening such as is used for windows, and this screen is connected to ground, or to A plus on the adapter. The bottom side of the shielding is attached to the subpanel rather than to the box, but in such a manner that it touches no conductor except the A plus lead and the screening in the sides and top of the containing box. Contact between the subpanel screen and the screening on the box is made automatically when the adapter is slipped into the box.

5SW, Chelmsford, broadcasts daily except Saturdays and Sundays, from 12.30 p.m. to 1.30 p.m., and from 7 p.m. to midnight, British Summer or Greenwich Mean time, according to the season; and PCJ every Thursday from 6 p.m. to 8 p.m., and from 11 p.m. to midnight, every Friday from midnight to 3 a.m., and from 6 p.m. to 8 p.m., and Saturday from midnight to 6 a.m., all Greenwich Mean time. The German station is not on a regular schedule.

British Summer time bears the same relation to Greenwich Mean time as Daylight Saving time bears to standard time in this country. Greenwich Mean time is five hours faster than Eastern Standard time, six hours faster than Central Standard time, seven hours faster than Mountain Standard time, and eight hours faster than Pacific Standard time.

Construction of Coils

Those wishing to construct their own coils can do so by following the following specifications:

Wave length range meters	L2 *Wire*	*Turns*	L3 *Wire*	*Turns*
16-32	Litz	7	No. 24 enameled	7
29-58	Litz	15	No. 28 enameled	10
54-110	Litz	25	No. 28 enameled	20
103-210	No. 28 enam.	47	No. 28 enameled	29

All are space-wound in threaded groove. Diameter of all 1.25 inches.

[The designer of this adapter, John F. Barry, Box 18, White Plains, N. Y., has kindly consented to answer questions regarding this circuit to those who write him enclosing a self-addressed stamped envelope for reply.—EDITOR.]

RANGES OF METERS

How Scale May Be Increased

By J. A. Dowie

National Radio Institute

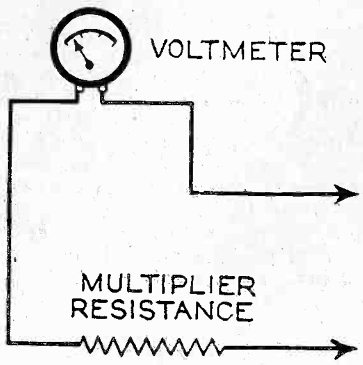

FIG. 1.

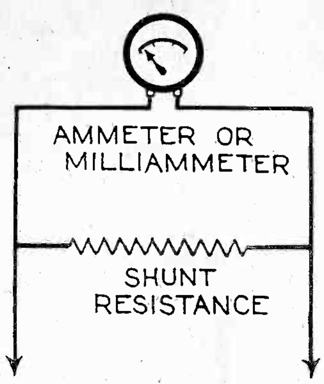

FIG. 2.

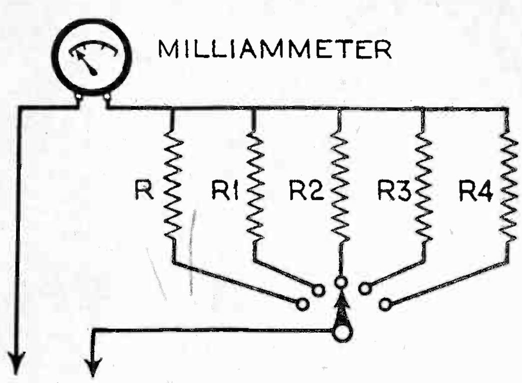

FIG. 3.

A SERIES RESISTOR INCREASES THE VOLTAGE SCALE OF A VOLTMETER (FIG. 1). A SHUNT RESISTOR INCREASES THE SCALE OF A CURRENT METER (FIG.2). A MILLIAMMETER IS SHOWN AS A MULTI-RANGE VOLTMETER (FIG. 3).

POSSESSION of the knowledge required to increase the range of indicating instruments, such as voltmeters and ammeters, permits the utilization of a device for some purpose which otherwise would necessitate a new instrument. Occasions frequently arise where current indicating devices at hand do not afford the operating range necessary for the test being conducted or measurement to be made.

A voltmeter may be used to measure voltages higher than its maximum scale reading by connecting a suitable resistance in series with the instrument. Such series resistances are known as multipliers. Similarly, the range of an ammeter or milliameter may be increased by using an appropriate resistance, which is connected in shunt or in parallel.

To increase the range of a voltmeter, it is necessary to place a resistance of the proper ohmic value in series with the instrument. This arrangement is shown in Fig. 1. The series resistance will have a value depending upon the maximum scale reading required of meter and upon the internal resistance of the meter itself. The internal resistance value may be obtained from the maker of the meter.

The application of the following formula when the internal resistance of the meter is known will make actual calculation very simple:

$$R1 = R\,(E1 - E)\;/E$$

R1 = Resistance connected in series with voltmeter.
R = Internal resistance of voltmeter.
E1 = Highest reading of voltmeter desired.
E = Highest present reading of voltmeter.

Thus, if we have on hand a voltmeter the maximum scale reading of which is 100 volts, with an internal meter resistance specified by its manufacturer as being equal to 100,000 ohms, and we wish to extend its range to indicate voltages up to 400 volts—

$$R1 = 100{,}000 \times \frac{(400 - 100)}{100} = 300{,}000 \text{ ohms.}$$

Series resistance = 300,000 ohms.

To obtain the scale readings with this extended range voltmeter, multiply the indicated meter reading by 4 (400 ÷ 100) which gives the difference of potential across both the voltmeter and added series resistance.

To increase the range of an ammeter or a milliameter, a shunt (parallel) resistance must be connected across its terminals, according to what maximum scale reading we desire. Fig. 2 illustrates how the shunt resistance is connected.

The value of the shunt resistance is determined from the following formula:

$$Rs = Ia \times Ra\;/\;Is$$

Rs = Shunt resistance.
Ra = Internal resistance of meter.
Ia = Original highest reading of meter.
Is = Current to flow through shunt.

The application underlying this formula is, however, possible only if and when the internal resistance of the meter is known.

The principle underlying this formula is that the total resistance of a path consisting of two or more resistances in shunt or in parallel is always less than the resistance of either one of the individual resistances. The current flow divides between the two branches, the sum of all the branches being the total circuit current. If we add in shunt to the internal resistance of the meter another resistance of equal value, the total resistance of the meter circuit consisting of the meter and the shunt resistance as shown in Fig. 2 is halved.

If the value of Rs is equal to Ra, the meter scale is doubled.

For determination of the shunt resistance let us assume Rs to be the required shunt resistance. Ra is the internal resistance of the meter. Ia is the meter current scale, I is the total current flow in the circuit and Is is the current which is to flow through the shunt resistance. As an example, let us assume a DC milliameter rated at 0-30 milliamperes (.03 of an ampere) and 1.2 ohms resistance, the operating scale of which we wish to increase to 150 milliamperes (.15 of an ampere). Since the meter is capable of only passing 30 milliamperes, 120 milliamperes (.12 of an ampere) must flow through the external shunt resistance.

Applying formula No. 2.

$$Rs = Ia \times Ra\;/\;Is$$

I = .15 ampere
Ia = .03 ampere
Is = .12 ampere

If we consider Ra as the internal resistance of the meter and Rs as the resistance of the shunt, we determine the value of the shunt resistance by solving the following formula:

$$Ra \times Ia\;/\;Is$$

Substituting our values, this formula reads $Rs = 1.2 \times (.03 \div .12)$, or .3 of an ohm. In other words, a shunt resistance of .3 of an ohm will increase the range of the above mentioned instrument to 150 milliamperes.

With a known value of meter resistance and a known value of shunt resistance, the multiplying factor or the increase in current range is determined by applying the following formula:

$$(Rs + Ra)/Rs$$

Rs = Shunt resistance
Ra = Meter resistance

Applying this formula to our problem and substituting our values, we obtain

$$(.3 + 1.2)/.3 = 5$$

In other words, the meter range is multiplied by 5.

By connecting an accurate fixed resistance in series with milliammeters, it is possible to make very useful voltmeters. For example, a standard milliammeter having a scale of 0 to 1 milliampere can be used as a very efficient voltmeter having convient ranges from 1 to 1,000, or even more volts by simply connecting in series with it multiples of suitable resistance and "calibrating" or simply reading the scale in volts instead of in amperes.

Fig. 3 shows a diagram with five external resistance connected to a 0 to 1 DC milliammeter. R is 1,000 ohms in series, and affords a voltage scale from 0 to 1 volt; R1 is 10,000 ohms resistance and extends the range of the meter to 0 to 10 volts:

R2 = 100,000 ohms; 0 to 100 volts
R3 = 200,000 ohms; 0 to 200 volts
R4 = 500,000 ohms; 0 to 500 volts
R5 = 1,000,000 ohms; 0 to 1,000 volts

HAS VERIFICATIONS

To Prove He Gets Foreign Stations

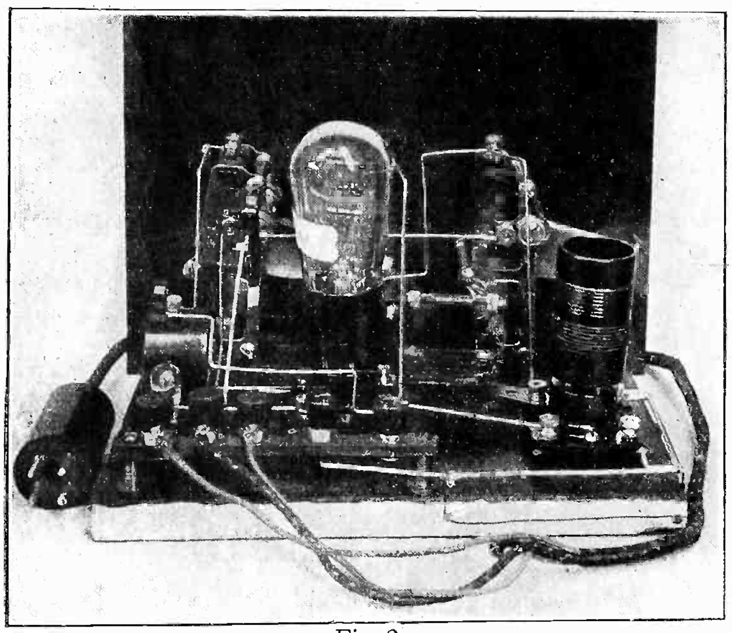

Fig. 2
A VIEW OF THE ADAPTER FROM THE REAR

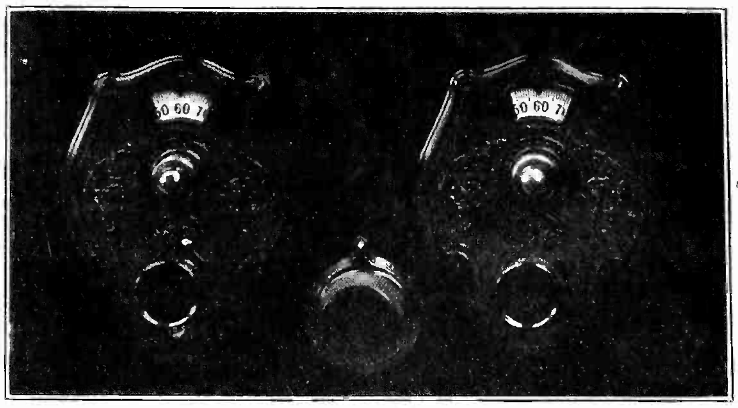

Fig. 3
THE APPEARANCE OF THE FRONT PANEL IF THE 7-INCH HEIGHT IS CUT DOWN, WHICH IS OPTIONAL

an adapter with an extraordinary array of amplifier tubes. But such is not the case. There is only one tube in the adapter, and I plug it into the detector socket of my broadcast receiver, thus using the amplifier in that circuit. As a matter of fact, there is nothing unusual about the circuit diagram of his adapter. The secret, if there be one, is in the use of first class parts, put together in the proper way, and handled by one who has learned how to tune. A glance at the circuit diagram, Fig. 1, will show the simplicity of the adapter.

In the antenna circuit is a double throw, double pole switch by means of which either the broadcast wavelengths or the short wave adapter may be selected, or rather by means of which the antenna may be thrown to one or the other.

Much depends on the antenna for the success of short wave receivers, so it is well to describe the antenna used in my set. It consists of 100 feet of No. 14 solid enameled copper wire erected in the form of an inverted L with the horizontal portion running North and South, the lead-in being taken off at the South end. Naturally, it is well insulated so that no part of the short wave signal is frittered away in insulation leakage. The ground lead goes to the cold water system of the house. That is the type of antenna and ground that can be recommended for almost any radio installation.

Starting with the antenna lead when the switch is thrown to the short wave adapter we first come to a midget condenser C1 which is in series with the antenna and the tuned circuit. This condenser is for the purpose of "shortening" the antenna and to make it suitable for the short waves. It is a thirteen-plate variable condenser.

One side of this condenser connects with the top of the tuned circuit and with the grid leak R1 and stopping condenser C4. The leak has a value of 10 megohms and the condenser .00015 mfd.

The tuned circuit consists of a straight line frequency condenser C2 of .00014 mfd. and a short wave coil L2. The tickler circuit is of the shunt type and consists of the coil L3 and another .00014 mfd. condenser C3. The rotors of both C2 and C3 are grounded, which explains the reason why there is no body capacity effects in the circuit even when critical regeneration is used.

In order to force the radio frequency currents through the tickler a radio frequency choke coil L1 is connected in the plate circuit of the tube. Also, a .001 mfd. by-pass condenser C5 is connected across the output to prevent any radio frequency currents from wandering into parts of the circuit where they don't belong.

Best results are obtained with a 112A tube in the adapter. Any other tube, including a screen grid tube, gave poorer results. A necessary condition for optimum results is that a rheostat be used in the filament circuit of the tube. The rheostat, Rh, is put in the negative leg of the filament circuit and its maximum resistance is 6 ohms. The socket used for the tube is of the cushioned type to minimize mechanical vibration of the elements.

The filament and plate leads of the adapter terminate on a binding post strip marked A plus, A minus and P. This is used for convenience and to provide an anchor for the leads. To this binding post strip are connected the flexible leads to the plug which is inserted into the detector socket of the broadcast receiver. A view of this plug is shown at the right in the drawing with the leads running to proper prongs. The view is taken from above the plug as it would be inserted. Note that the two filament leads are reversed from the usual connection. This happened to be the proper connection for the broadcast amplifier used with this adapter. If the broadcast amplifier is wired in the usual manner these two leads should be reversed. Of course, the essential thing is that plus goes to plus and minus to minus regardless of the manner in which the receiver has been wired. Before connecting the leads to the plug the polarity of the detector socket springs in the broadcast receiver should be tested to avoid any mistake.

The tuning coils L2 and L3 are wound on a small form 1.25 inches in diameter and are provided with a standard tube base prong which fits into a cushion type socket. Thus change of coils from one wavelength range to another is done in a moment.

Batteries should be used both for the filament current and the plate voltage. Eliminators are not recommended. The plate voltage on the tube is 45 volts, supplied, however, through a variable resistance located in the broadcast receiver and not shown in the adapter diagram. A resistance having a maximum value of 50,000 ohms is suggested.

In addition to using batteries not only on the adapter tube but also on the broadcast receiver used in conjunction with it, I strongly recommend individual rheostats on all the tubes used in preference to automatic filament control or fixed ballast resistors.

In order to eliminate all body capacity effects the entire adapter is shielded. The box containing the adapter is lined with phosphor bronze screening such as is used for windows, and this screen is connected to ground, or to A plus on the adapter. The bottom side of the shielding is attached to the subpanel rather than to the box, but in such a manner that it touches no conductor except the A plus lead and the screening in the sides and top of the containing box. Contact between the subpanel screen and the screening on the box is made automatically when the adapter is slipped into the box.

5SW, Chelmsford, broadcasts daily except Saturdays and Sundays, from 12.30 p.m. to 1.30 p.m., and from 7 p.m. to midnight, British Summer or Greenwich Mean time, according to the season; and PCJ every Thursday from 6 p.m. to 8 p.m., and from 11 p.m. to midnight, every Friday from midnight to 3 a.m., and from 6 p.m. to 8 p.m., and Saturday from midnight to 6 a.m., all Greenwich Mean time. The German station is not on a regular schedule.

British Summer time bears the same relation to Greenwich Mean time as Daylight Saving time bears to standard time in this country. Greenwich Mean time is five hours faster than Eastern Standard time, six hours faster than Central Standard time, seven hours faster than Mountain Standard time, and eight hours faster than Pacific Standard time.

Construction of Coils

Those wishing to construct their own coils can do so by following the following specifications:

Wave length range meters	*L2 Wire*	*Turns*	*L3 Wire*	*Turns*
16-32	Litz	7	No. 24 enameled	7
29-58	Litz	15	No. 28 enameled	10
54-110	Litz	25	No. 28 enameled	20
103-210	No. 28 enam.	47	No. 28 enameled	29

All are space-wound in threaded groove. Diameter of all 1.25 inches.

[*The designer of this adapter, John F. Barry, Box* 18, *White Plains, N. Y., has kindly consented to answer questions regarding this circuit to those who write him enclosing a self-addressed stamped envelope for reply.*—EDITOR.]

RANGES OF METERS

How Scale May Be Increased

By J. A. Dowie

National Radio Institute

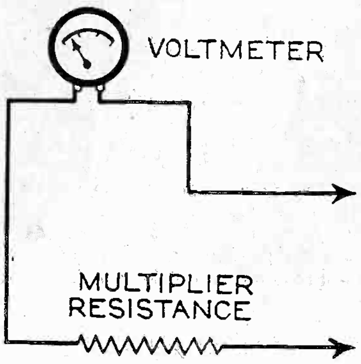

FIG. 1.

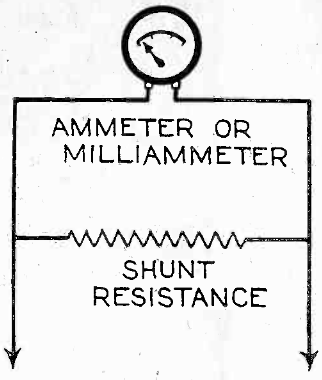

FIG. 2.

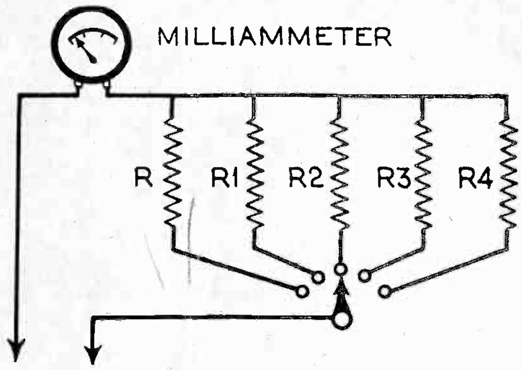

FIG. 3.

A SERIES RESISTOR INCREASES THE VOLTAGE SCALE OF A VOLTMETER (FIG. 1). A SHUNT RESISTOR INCREASES THE SCALE OF A CURRENT METER (FIG.2). A MILLIAMMETER IS SHOWN AS A MULTI-RANGE VOLTMETER (FIG. 3).

POSSESSION of the knowledge required to increase the range of indicating instruments, such as voltmeters and ammeters, permits the utilization of a device for some purpose which otherwise would necessitate a new instrument. Occasions frequently arise where current indicating devices at hand do not afford the operating range necessary for the test being conducted or measurement to be made.

A voltmeter may be used to measure voltages higher than its maximum scale reading by connecting a suitable resistance in series with the instrument. Such series resistances are known as multipliers. Similarly, the range of an ammeter or milliameter may be increased by using an appropriate resistance, which is connected in shunt or in parallel.

To increase the range of a voltmeter, it is necessary to place a resistance of the proper ohmic value in series with the instrument. This arrangement is shown in Fig. 1. The series resistance will have a value depending upon the maximum scale reading required of meter and upon the internal resistance of the meter itself. The internal resistance value may be obtained from the maker of the meter.

The application of the following formula when the internal resistance of the meter is known will make actual calculation very simple:

$$R1 = R\,(E1 - E)\;/E$$

R1 = Resistance connected in series with voltmeter.
R = Internal resistance of voltmeter.
E1 = Highest reading of voltmeter desired.
E = Highest present reading of voltmeter.

Thus, if we have on hand a voltmeter the maximum scale reading of which is 100 volts, with an internal meter resistance specified by its manufacturer as being equal to 100,000 ohms, and we wish to extend its range to indicate voltages up to 400 volts—

$$R1 = \frac{100{,}000 \times (400 - 100)}{100} = 300{,}000 \text{ ohms.}$$

Series resistance = 300,000 ohms.

To obtain the scale readings with this extended range voltmeter, multiply the indicated meter reading by 4 ($400 \div 100$) which gives the difference of potential across both the voltmeter and added series resistance.

To increase the range of an ammeter or a milliameter, a shunt (parallel) resistance must be connected across its terminals, according to what maximum scale reading we desire. Fig. 2 illustrates how the shunt resistance is connected.

The value of the shunt resistance is determined from the following formula:

$$Rs = Ia \times Ra\;/\;Is$$

Rs = Shunt resistance.
Ra = Internal resistance of meter.
Ia = Original highest reading of meter.
Is = Current to flow through shunt.

The application underlying this formula is, however, possible only if and when the internal resistance of the meter is known.

The principle underlying this formula is that the total resistance of a path consisting of two or more resistances in shunt or in parallel is always less than the resistance of either one of the individual resistances. The current flow divides between the two branches, the sum of all the branches being the total circuit current. If we add in shunt to the internal resistance of the meter another resistance of equal value, the total resistance of the meter circuit consisting of the meter and the shunt resistance as shown in Fig. 2 is halved.

If the value of Rs is equal to Ra, the meter scale is doubled.

For determination of the shunt resistance let us assume Rs to be the required shunt resistance. Ra is the internal resistance of the meter. Ia is the meter current scale, I is the total current flow in the circuit and Is is the current which is to flow through the shunt resistance. As an example, let us assume a DC milliameter rated at 0-30 milliamperes (.03 of an ampere) and 1.2 ohms resistance, the operating scale of which we wish to increase to 150 milliamperes (.15 of an ampere). Since the meter is capable of only passing 30 milliamperes, 120 milliamperes (.12 of an ampere) must flow through the external shunt resistance.

Applying formula No. 2.

$$Rs = Ia \times Ra\;/\;Is$$

I = .15 ampere
Ia = .03 ampere
Is = .12 ampere

If we consider Ra as the internal resistance of the meter and Rs as the resistance of the shunt, we determine the value of the shunt resistance by solving the following formula:

$$Ra \times Ia\;/\;Is$$

Substituting our values, this formula reads $Rs = 1.2 \times (.03 \div .12)$, or .3 of an ohm. In other words, a shunt resistance of .3 of an ohm will increase the range of the above mentioned instrument to 150 milliamperes.

With a known value of meter resistance and a known value of shunt resistance, the multiplying factor or the increase in current range is determined by applying the following formula:

$$(Rs + Ra)\;/Rs$$

Rs = Shunt resistance
Ra = Meter resistance

Applying this formula to our problem and substituting our values, we obtain

$(.3 + 1.2)/.3 = 5$

In other words, the meter range is multiplied by 5.

By connecting an accurate fixed resistance in series with milliammeters, it is possible to make very useful voltmeters. For example, a standard milliammeter having a scale of 0 to 1 milliampere can be used as a very efficient voltmeter having convient ranges from 1 to 1,000, or even more volts by simply connecting in series with it multiples of suitable resistance and "calibrating" or simply reading the scale in volts instead of in amperes.

Fig. 3 shows a diagram with five external resistance connected to a 0 to 1 DC milliammeter. R is 1,000 ohms in series, and affords a voltage scale from 0 to 1 volt; R1 is 10,000 ohms resistance and extends the range of the meter to 0 to 10 volts:

R2 = 100,000 ohms; 0 to 100 volts
R3 = 200,000 ohms; 0 to 200 volts
R4 = 500,000 ohms; 0 to 500 volts
R5 = 1,000,000 ohms; 0 to 1,000 volts

TUNING THE

By Herman

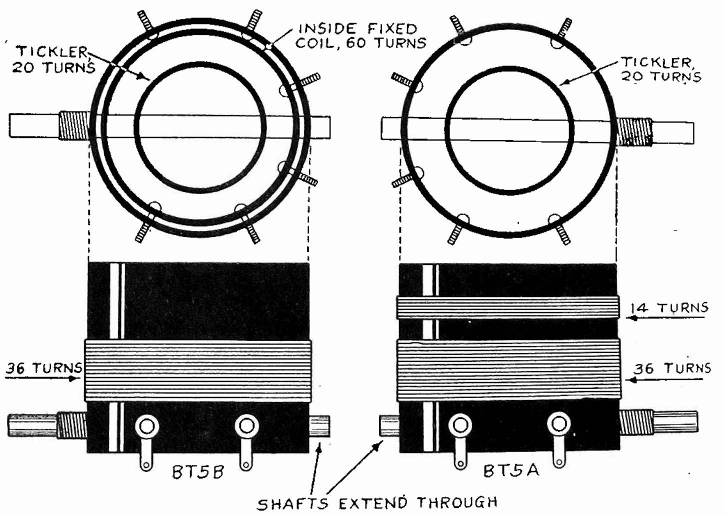

FIG. 1.
THE WINDING DATA FOR .0005 MFD. CONDENSERS, FOR COILS ON A 2½" OUTSIDE DIAMETER FOR THE MAIN FORM, ARE INDICATED.

[*The main constructional features of the HB Compact, a four-tube battery model receiver, using two screen grid tubes, one 240 high mu and a 112A output tube, were published in the August 24th and 31st issues. In the August 31st (last week) the full-sized picture diagram of the wiring was printed. The circuit, using the new Bernard dynamic tuners for working the screen grid radio frequency amplifier up to the hilt, and for making the dials track, is exceptionally sensitive, provides adequate selectivity, and is wonderful on tone. Its construction is highly recommended, as this circuit has proved to be one of the best of the sets using few tubes so far designed.—Editor.*]

THE details on construction of the HB Compact have been published, and some questions have been received from readers, but it is not quite time to answer all these questions, as it was promised that this week tuning would be discussed, and next week, issue of September 7th, the topic would be trouble-shooting. Nevertheless, if you will turn to pages 14 and 15 you will see some questions answered, because it was deemed these were especially urgent.

Lest the reader has not read any of the foregoing articles a few words on the theory and design of the circuit will be written, and the coil winding data given.

The circuit consists of a screen grid radio frequency amplifier, with the grid and plate circuits of the same tube tuned; a 240 high mu detector, worked on the negative bias principle; a screen grid first stage audio amplifier, and a 112A output tube. Those desiring a 171A output tube may make the substitution, but must increase the last stage plate voltage to 180, use a filter and provide 40.5 volts negative bias for the 171A.

High-Gain Audio, Also

The two-stage audio amplifier is resistance-coupled, and the gain is at least as great as that provided by a pair of audio transformers, while the tone is second to nothing ever produced in radio. The first audio stage screen grid tube accounts for the high volume, despite the use of only two stages of resistance coupling, where three stages were the previous rule with ordinary tubes or modestly high mu tubes.

In the radio tuner a new system is used, embodying the dynamic RF coil invented by the author, where the secondary is a single coil in two series-connected parts. One (dynamic) winding is on a rotatable form, and is connected in series with a fixed (static) winding, which is on the outside form. The tuning condenser is connected across the entirety, that is, across the combination of the static coil and the dynamic coil. The variometer effect of the moving coil or dynamic segment works in the same direction as does the tuning condenser which has its shaft coupled to the shaft of the moving coil. The same tuning motion turns both moving coil and condenser rotor simultaneously. Thus the frequency range is extended.

But in this particular circuit a very large starting capacity appears in the tuned plate circuit, and the dynamic coil system is used to enable covering the entire broadcast band with usual condensers, .0005 mfd. or .00035 mfd., despite this high-minimum-capacity handicap. The dynamic achievement is absolutely a solution of the difficulty, and is the only way to cover the full band while still working the screen grid tube up to its practical maximum of amplification, a degree of sensitivity that will prove utterly astonishing.

Doubter Turns Booster

The circuit diagram is republished this week as Fig. 2 so that readers who are getting their first view of the diagram, and reading about the circuit for the first time, may have a clear picture of the electrical requirements. As a further aid, coil data will be given again.

Regarding those who have read previous articles on the subject of this new system of tuning, with full-gain screen grid amplification, it will be recalled that preliminary articles were published late in July and early in August, and that they immediately evoked letters by the armful. Some few wrote in wondering whether the circuit worked at all, as they had read glowing accounts of other circuits (not of my design, and not in RADIO WORLD) and had considered themselves stung. I mentioned some of these letters in a previous article, and gave new assurances that the HB Compact, battery model, is indeed all that I said it was, though secretly believing it was more.

It so happens that last Saturday afternoon a young man visited me at my office and identified himself as the writer of one of the doubting letters, one I singled out for special reply. He had read my published answer and thereupon had built the circuit.

"I want to take back what I said," he apologized. "I saw only four tubes in the circuit, and some system of tuning I was not familiar with, therefore doubted, and noted the absence of regeneration from the detector, so I wondered if the circuit could be all that you said it was. Well, after reading your reply I built the circuit, and I've come all the way from Camden, New Jersey, to New York City, to tell you that this circuit is the wonder of wonders, the dream of dreams, and the quintessence of what-have-you. Besides, its ten times, all of that, and ten times again!"

Sympathetic Toward Doubters

It was indeed gratifying to receive this enthusiastic report especially from one who had been the gloomiest of disbelievers, and most especially from a young man who travelled ninety miles to make an unnecessary apology, for set constructors who doubt the rosy descriptions of circuit performance have me on their side, rather than against them, because I, too, have read no end of articles on circuits, where the enthusiasm must have come only from the hands, and not from the head, most certainly not justified by the ordinary circuit that was touted to the skies. Any praise sung for the present circuit comes from the head, and from the heart.

Moreover I have received some letters from impatient readers who have built the circuit and who will take my place in the ballyhoo. Some of these letters will be published soon in RADIO WORLD, so if there is one last lingering doubter on the list, let him read these letters and make his peace with his imaginary enemy.

The coil winding is not a job, but the material with which to work has to be available. This consists of the odd requirement of a tickler form with a shaft protruding from front and rear. That is, the tickler shaft goes all the way through. This is necessary so that the panel-mounted coils may present a rear-extending shaft for connection by flexible coupler or link to the shaft of the tuning condenser. Note, therefore, that condensers with extending rear shafts are not required, since the coils afford this connection facility.

However, if pressed on this point, you may mount on the front panel tuning condensers that do have rear shaft protruding, and connect the rear of the condenser shaft to the front and only shaft of a modified home-constructed tuner. The picture diagram is not schemed out that way and you will have to improvise the slight difference in making connections.

Data on Coils

If an outside form of 2½" diameter is used for L1L2, this form may be 2½" high. See Fig. 1. The number of turns on the antenna coil primary, L1, is 14. A space of ¼" or ⅜" is left and another winding put on, separately. This has 36 turns. The tickler form should be small enough to rotate inside the other without striking the inside wall of the outside form. An outside diameter of 1¾" for the tickler will provide this safety. Wind 20 turns on the tickler, 10 on each side of where the tickler shaft pierces the moving coil's form. Connect one end of the dynamic or moving coil to one end of the 36-turn winding. Connect the tuning condenser to the remaining terminals of the series-connected coils. The wire may be No. 24 silk covered throughout.

HB Compact

Bernard

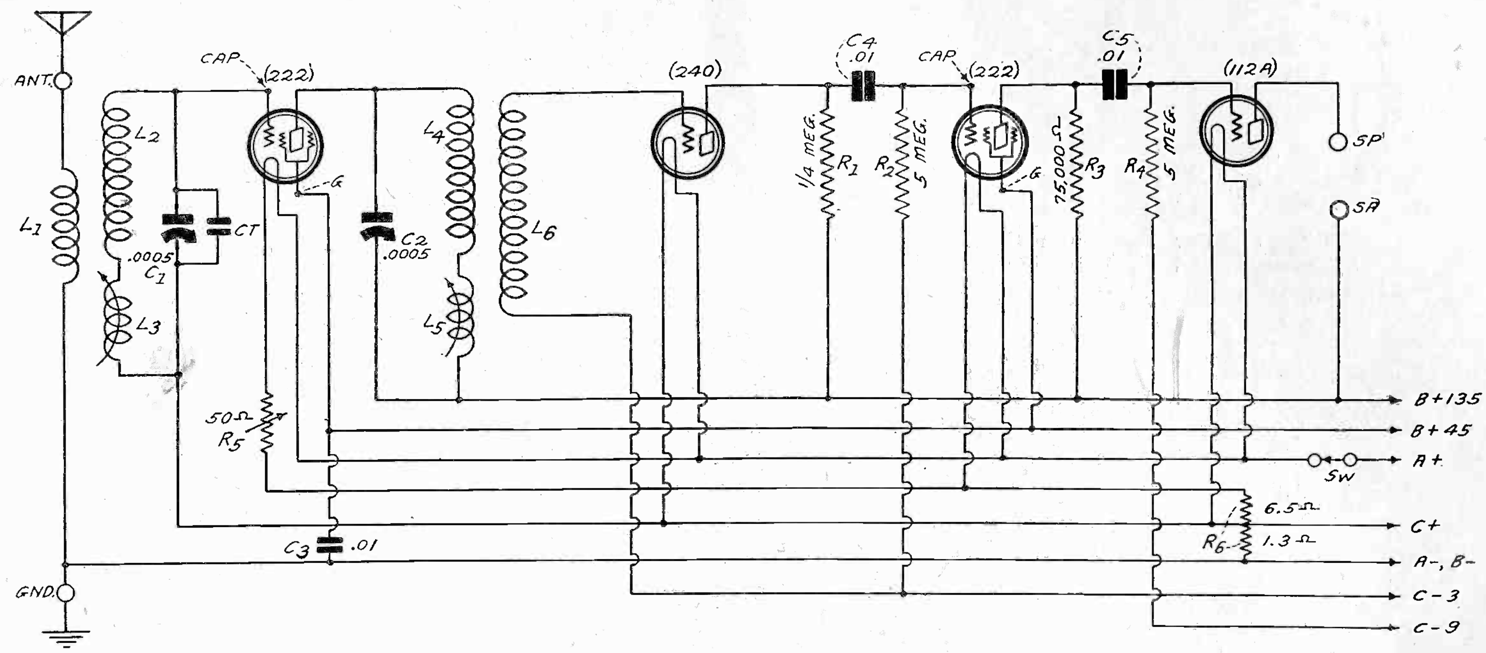

FIG. 2.
THE REDUCTION IN VOLTAGE ON THE FIRST TUBE BY THE RHEOSTAT R5 INCREASES THE VOLTAGE ON THE OTHER TUBES A TRIFLE. THIS IS PERMISSIBLE.

The inductance described is Cat. BT5A, made by the Screen Grid Coil Company, for .0005 mfd., and is shown at right in Fig. 1.

The other coil, BT5B, for interstage coupling, is different. The same size forms are used for outside stationary and inside moving coil, but there is a third form, slipped inside the other fixed form, and this third form has 60 turns on it. The data are: 20 turns on tickler, 36 turns on outside stationary winding, as in previously-discussed model, then 60 turns on a 2⅛" diameter tubing, to constitute L6. The interconnection of the 20-turn tickler and the 36-turn outside fixed winding leaves in reality two coils—the combination static and dynamic windings for tuning the plate circuit, L4L5, and the pickup coil to feed the 240 detector.

The Parallel Capacity

The large pickup coil, establishing a step-up ratio, helps the amplification tremendously, and as the Bernard tuner compensates for the distributed capacity arising, there is every reason to use this step-up.

The foregoing data are for .0005 mfd. If .00035 mfd. is used, add 10 turns to the 36-turn winding and 20 to the 60-turn.

The circuits will not tune alike unless compensated, because of the difference in starting capacities. Therefore a condenser has to be placed in parallel with the first tuning condenser, C1, to provide an amount of capacity equal to that developed in the succeeding plate circuit by the high-amplification device. What this capacity should be can not yet be accurately foretold for all installations, but 80 or 90 mmfd. was suggested, although it is known that in some instances more capacity than this will be required. The only difference, of course, is that where the capacity added to the first tuned circuit is not large enough, the dials will not track. Tune in a low wavelength station. The dials will read differently. Turn the first dial until it reads the same as the second. This tunes out the station. Do not molest the second dial. Now add the capacity across the first tuning condenser. A small fixed condenser, .0001 mfd., may be tried, and for finer adjustment the 80 or 90 mmfd. condenser may be placed across that, until the station comes in again. But at all hazards some definite capacity value will give you the same dial settings for both tuned circuits.

The Function of the Rheostat

Not enough receivers have been built so far to permit of specifying an average capacity that would mean something, but after about twenty or thirty receivers have been tested in the laboratory in that way, an average will be struck, and probably a fixed capacity will be specified. Meanwhile an adjustable one is advised, and it may as well be a high capacity, or two small ones in parallel, as two 80 mmfd. The only difference, as was stated before, is dissimilarity of dial settings, if the proper capacity is not put in parallel. No difference in the sensitivity, selectivity or tone obtains, and moreover the whole broadcast spectrum will be tuned in even without any equalizing capacity across the first stage. It is the Bernard tuner in the plate circuit that guarantees full coverage of broadcast frequencies.

In tuning the receiver it will be found that the volume control has not much effect when only part of its resistance is thrown into circuit. This is due to the very high amplification. You can attenuate the signal so much that an ordinary receiver would suffer utter loss of signal, yet this receiver still brings in the signal loud as you would want, and more and more of the resistance has to be cut in. Therefore a rheostat of 60, 75 or 100 ohms should be used, not one of 20 or 30 ohms. The specifications call for a 75-ohm resistor, but some resistance more or less will not make a material difference.

The rheostat serves also to get rid of any regenerative effects produced in tuning in lower wavelengths. When the rheostat is turned to full a position of greatest resistance, the tubes other than the RF tube will light a little more brightly. It is just a little, and no harm results. The reason is the common resistance that serves all four tubes.

As the current through the first tube's filament is reduced, because of increased use of resistance in R5, the current through this common resistor, between A minus and C plus, is lowered, and the voltage drop in that section is therefore less, hence the applied voltage is higher on the three other tubes. The increase is so small that if the first tube were turned off entirely the higher voltage on the rest would rise only one-seventh, and, mind you, the first tube never is turned off unless all tubes are turned off. The switch on the rheostat prevents turning off only the first tube and leaving the others heated.

The first tuned circuit will seem to tune "more broadly" than the detector circuit, but this is scarcely a fact, merely an appearance. The first circuit tunes in a certain frequency and some other frequencies incidentally, as it alone has to select as best as possible from the full band. This is true of any circuit. The next stage, however, has the benefit of pre-selection by the first tuner, hence seems to tune more sharply. Appearances should not be counted at all, only the actual result, and it will be found that the stations will be tuned in satisfactorily without crosstalk interference.

The values of the resistors in the audio channel should be followed, except that in some instances motorboating may be experienced, whereupon a 50,000 ohm resistor should be used for R3 instead of 75,000 ohms, or across the 75,000-ohm resistor a leak should be connected, 1 or 2 meg. or thereabouts.

[*Last week's constructional article was a textual description of building the HB Compact, battery model, illustrated with a full-size picture diagram that occupied two full pages. Therefore the diagram had to be on different pages than the text, although on the succeeding two pages. References to the diagram were many, and it is suggested you obtain two copies of the August 31st issue, so you can also have the picture diagram before you while you read the textual wiring instructions.—Editor.*]

TABLE II.
Average Characteristics of Rectifier and Voltage Regulator Tubes

Type	Use	Filament supply	Filament terminal voltage	Filament current (amperes)	Filament Resistance (ohms)	Maximum voltage per plate, R.M.S.	Maximum rectified current (milliamperes)
UX 280	Full Wave Rectifier	A.C.	5.0	2.0	2.5	350	110
UX 281	Half Wave Rectifier	A.C.	7.5	1.25	6.0	700	85
UX 274	Voltage Regulator	Rated voltage, 90 D.C. Starting voltage, 125 D.C. Max. direct current, 50 MA.					
UX 276*	Ballast Tube	Current rating, 1.7 amps. Voltage range 40-60					
UX 286*	Ballast Tube	Current rating, 2.05 amps. Voltage range, 40-60					

* Standard mogul type screw base.

TABLE III.
Grid Voltage, Plate Current Characteristics of the 220 Tube

Eg \ Ep	45	90	135	180
0	4.4	12	20.5	27.0
—5	2.5	9	17.5	24.0
—10	1.0	6.3	14.2	21.0
—15	0	3.7	11.2	18.0
—20		.7	8.5	16.8
—25		0	5.7	13.7
—30			3.5	10.5
—35			1.7	7.8
—40			.5	5.3
—45			0	3.0
				1.4

TABLE IV.
Grid Voltage, Plate Current Characteristics of the 201A Tube

Eg \ Ep	45	90	135
0	1.7	5.7	13.0
—2	.7	3.7	9.1
—4	.2	2.3	7.2
—6		1.2	4.8
—8		.3	3.3
—10		0	1.8
—12			1.0

TABLE V.
Grid Voltage, Plate Current Characteristics of the 112A Tube

Eg \ Ep	45	90	135	180
0	2.8	14	24	34
—2.5	1.5	8.6	19	29
—5	0	4.5	14.5	24.5
—7.5		1.5	9.0	19.3
—10		0	4.5	15.5
—12.5			1.6	10.3
—15			0	5.7
—17.5				2.2
—20				.5
—22.5				
—25				

TABLE VI.
Grid Voltage, Plate Current Characteristics of the 171A Tube

Eg \ Ep	45	90	135	180	220
0	13	38.5	70	102	134
—10	2	20.0	48	77	102
—20	0	6	29	58	77
—30		0	12	38	66
—40			2	20	44
—50			0	6.5	26
—60				0	10
—70					1
—80					0

TABLE VII.
Grid Voltage, Plate Current Characteristics of the 222 Screen Grid Tube

Screen Grid Voltage +45 volts.

Eg \ Ep	90	135	180
0	1.90	1.98	2.05
—1.5	1.45	1.48	1.51
—3.0	.90	.95	1.00
—4.5	.55	.60	.61

PICK-UP C

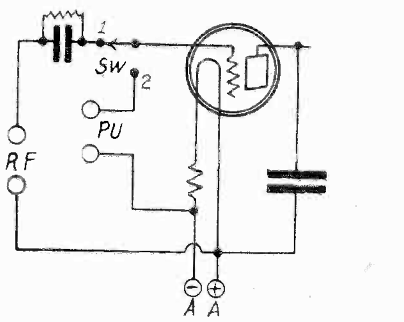

FIG. 78

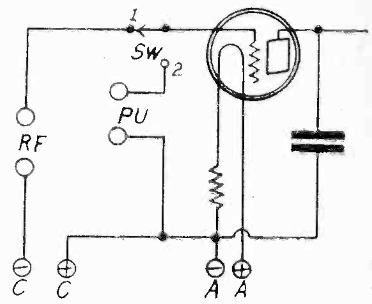

FIG. 79

TABLE VIII.
Grid Voltage, Plate Current Characteristics of the 240 Tube

Eg \ Ep	45	90	135	180
0	.24	.63	1.55	2.47
—1	.04	.30	.92	1.54
—2	0	.09	.48	1.22
—3		0	.22	.69
—4			.05	.34
—5			0	.20
—6				0
—7				

TABLE IX.
Grid Voltage, Plate Characteristics of the 227 Heater Tube

Eg \ Ep	45	67.5	90	112.5	135	157.5	180
0	5.4	7.0	10.2	13.6	17.0	20.4	23.8
—2	2.4	4.8	7.65	11.0	14.15	17.3	20.45
—4	1.0	2.95	5.35	8.35	11.55	14.7	17.85
—6	.1	1.4	3.4	5.95	8.9	12.05	15.20
—8		.4	1.9	3.95	6.55	9.55	12.70
—10			.75	2.3	4.45	7.05	10.2
—12			.1	1.1	2.80	5.00	7.75
—14				.3	1.45	3.20	5.45
—16					.62	1.9	5.7
—18					.1	.95	2.25
—20						.30	1.24
—22							.57
—24							.10

TABLE X.
Grid Voltage, Plate Current Characteristics of the 245 Tube

Eg \ Ep	90	180	250
0	40	97	142
—10	22	74	119
—20	7.0	52	97
—30	.5	32	74
—40		15	52
—50		4.0	32
—60		1.0	15
—70			4.0
—80			1.0

TABLE XI.
Grid Voltage, Plate Current Characteristics of the 224 Heater Type Screen Grid Tube. Screen Voltage +75 Volts.

Eg \ Ep	135	180
0	5.45	5.55
—1.5	3.875	4.00
—3.0	2.55	2.65
—4.5	1.45	1.5
—6.0	.4	.7

[Herewith is fifteenth consecutive weekly instalment of J. E. Anderson's and Herman Bernard's book, "Power Amplifiers," which is being printed serially. The tables referring to tubes are a direct continuation of last week's article, while the connections for phonograph pickups and microphones introduces a new subject. Another interesting instalment will be published next week. Power detection will be the topic.—Editor.]

Playing Phonograph Records

In modern broadcast receivers provision is often made for connecting a phonograph pick-up unit to the circuit so that the audio

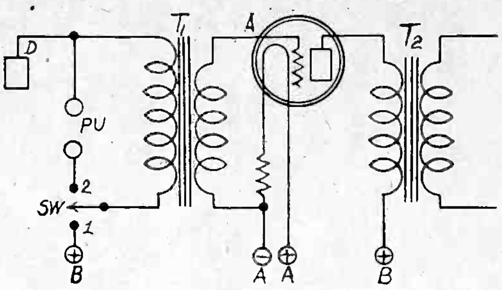

FIG. 82
THE PROPER METHOD OF CONNECTING THE PICK-UP UNIT IN SERIES WITH THE TRANSFORMER PRIMARY.

ONNECTIONS

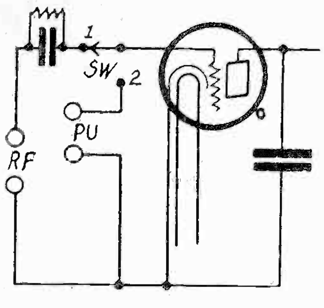

FIG. 80

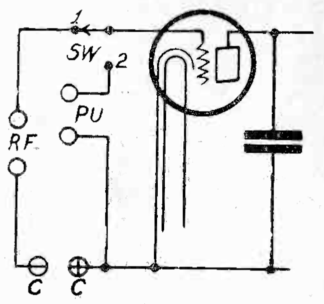

FIG. 81

amplifier may be used for playing records electrically. There are many different ways in which the pick-up unit can be connected, but not all those which have been used are suitable.

The most common method used when the amplifier was not originally designed for record playing is to plug the pick-up unit into the detector socket so that the pick-up terminals make contact with the plate spring and one of the filament springs on the socket. This put the pick-up unit in series with the primary of the first audio transformer and also with the plate battery. This connection should never be used because a current is continually flowing in the circuit, and this current changes the characteristics of both the audio transformer and the pick-up unit. Moreover, it drains the battery when no current is necessary.

The pick-up unit should be connected either in the grid circuit of the detector tube in such a manner that the detector tube becomes an amplifier or else in series with the primary of the first audio transformer in such manner that the plate voltage source is excluded from the circuit. If either of these connections gives so much amplification that the volume control on the pick-up unit, or the volume control in the amplifier, if any, does not have sufficient range to limit the output to desired values, then the pick-up unit can be connected in the grid circuit of the tube following the detector, or in series with the primary of the second transformer.

Fig. 78 illustrates a proper connection of the pickup unit in the grid circuit of a detector employing grid condenser and leak. The pick-up unit is connected across the terminals marked PU. One of these terminals is connected to minus A below the ballast resistor. The other is connected to one point of a single pole, double throw switch SW. When the amplifier following the detector is to be used for radio reception the switch is turned to point (1), thus picking up the tuned circuit and disconnecting the pick-up unit. The tube is then adjusted for detection. When the pick-up unit is to be used the switch is turned to point (2), disconnecting the tuner and converting the detector to an amplifier having a negative grid bias equal to the drop in the ballast resistor.

Fig. 79 illustrates the same connection when the detector operates on the grid bias principle. The return of the PU is now made so that the greater portion of the grid bias battery is excluded from the circuit when the tube is to be used as an amplifier. As in the preceding case the only bias retained is the drop in the ballast resistor. This is sufficient because the signal voltage from the pick-up unit will be much less than the bias thus provided.

When the detector tube is of the heater type, the pick-up unit can be returned directly to the cathode as in Fig. 80. This does not provide any bias. None is really necessary because the signal voltage is very small. However, it is a simple matter to provide bias by returning the pick-up unit to a point of lower potential than the cathode, for example, to the point where the grid return of the first audio amplifier is made. It is assumed that the cathode of the detector tube is connected to the cathode of the following tube.

Another way of providing a small bias is to insert a low value resistor between the cathode and the point where the pick-up unit is returned. This can be done without appreciably changing the detecting efficiency of the tube.

If the heater type detector is operated on the grid bias principle, the pick-up unit can be connected as in Fig. 81. While the pick-up unit is here connected to the cathode, it may be connected as suggested in Fig. 80 to get a small negative bias.

If the grid bias for detection is obtained from a battery, the pick-up unit may be returned to a point on this battery about 1.5 volts from the cathode, thus making the bias 1.5 volts negative for amplification. A small resistance also may be inserted in the cathode lead above the pick-up return point to provide a small bias. It makes no difference whether the negative bias for detection is obtained from a voltage drop in a resistance or from a battery.

One reason why it is not essential to have a negative bias on the tube when it is used as an amplifier for phonograph signals is that the impedance of the pick-up unit is relatively small, so that any grid current that will flow will not produce a great drop in the signal voltage impressed on the tube.

If it is desired to connect the pick-up unit in series with the primary of the first transformer, it may be done as in Fig. 82. One side of the pick-up unit is connected permanently to the plate of the tube and the top of the transformer. The other side of the unit is connected to a point on the double throw, single pole switch SW. When the pick-up unit is to be connected to the transformer the switch is thrown to point (2). This disconnects the plate voltage so that no direct current can flow either in the tube or in the pick-up and transformer circuit. When the amplifier is to be used with the tuner, the switch is set on point (1). This disconnects the pick-up unit and puts the tube and the transformer primary on the battery.

Sometimes a matching transformer is used between the pick-up unit and the audio coupling transformer to get a louder signal and improved quality. The method of connecting this transformer is shown in Fig. 83, T1 being the matching transformer and T2 the audio coupling transformer. The primary of T1 is provided with a number of taps for adjusting the impedance of the primary to the impedance of the pick-up unit. The secondary of T1 is supposed to have the same impedance as the primary of T2.

The switch SW2 is for selecting either the radio signal or the signal from the pick-up unit. The B battery may be connected permanently to the junction of T1 and T2 because when the switch is set on point (2) no direct current can flow in the circuit formed by the secondary of T1 and the primary of T2. When the switch is set on point (1), the matching transformer is thrown out of the circuit and the plate circuit of the detector tube is established through the primary of T2.

The coupling transformer can be used with any of the connections illustrated in Figs. 78 to 82 inclusive. It is necessary only to connect the secondary terminals of T1 to the points labeled PU in these circuits and leaving the terminals of the pick-up unit on the primary of T1.

The use of the matching transformer in any case is of doubtful advantage. The matching is based on the assumption that best results will be obtained when the pick-up unit delivers maximum power. What is desired is the maximum voltage on the grid of the amplifier, and this is obviously not obtained when one-half of the voltage generated in the pick-up unit is wasted in the impedance of the unit, which is the condition for maximum power output. The use of the matching transformer changes the quality somewhat. Whether this change is an improvement or a loss depends largely on personal taste as to what constitutes good quality.

While the pick-up unit has been put either in the grid circuit of the detector or in the primary of the first audio transformer in all the circuits shown in Figs. 78 to 83, inclusive, it may be better in some instances to put it in the grid circuit of one of the amplifier tubes or in series with the primary of the second transformer. Just where it should be put in any given amplifier depends on the amplification, the sensitivity of the pick-up unit, the volume desired, and on the effectiveness of the volume control built in with the pick-up unit. In most instances sufficient volume will be obtained if the unit is connected in the grid circuit of the amplifier ahead of the power tube.

Use of Microphone

Some experimenters often have occasion to use a microphone with their amplifiers, either for telephonic communication or for measuring sound intensities. The connection of a microphone to a power amplifier is essentially the same as the connection of a phonograph pick-up unit, and the terminals marked PU in the circuits in Figs. 78 to 81, inclusive, may be used for connecting the microphone output. What is meant by the output terminals is indicated in Figs. 84 to 87, inclusive.

The carbon button microphone operates on the principle of varying resistance. The sound waves exert a pressure on the diaphragm D, Fig. 84, and this in turn exerts a varying pressure on the carbon granules. The resistance of the carbon is lower, the greater the pressure. As long as the pressure on the carbon remains constant, a steady current flows from the battery E through the carbon and the primary of transformer T. As sound falls on the diaphragm, the resistance varies and therefore the current varies. This varying current flows through the primary of transformer T and induces a corresponding varying electromotive force in the secondary. The induced emf is alternating and can be impressed on the grid of an amplifying tube.

A push-pull carbon microphone is essentially two equal microphones placed back-to-back. A single diaphragm, D, Fig. 85, is

MICROPHONE USES

How to Hook Up the Four Main Types

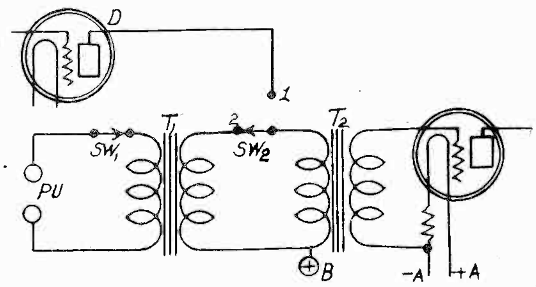

FIG. 83

placed between two equal carbon buttons C,C. Two equal circuits are formed by the two sides of the microphone, the battery E, and the two equal sides of the primary of transformer T. As the diaphragm vibrates, the resistance in one circuit is increased and that in the other decreased by the same amount. The current through the battery remains substantially constant, but that through the transformer primary alternates in the same manner as the sound that falls on the diaphragm. There is a DC component in each of the sides of the primary, but the component in one side neutralizes that in the other so that only the alternating component is effective. An alternating emf is induced in the secondary of the transformer, and this varies as the sound waves that fall on the diaphragm. The output emf can be impressed on the grid circuit of an amplifying tube.

Single and push-pull carbon microphones can be obtained at widely varying prices, depending on the accuracy with which they have been constructed. Transformers suitable for these transformers are also available. The manufacturers of the microphones specify what transformer should be used as well as what the value of the voltage E should be.

Where exceptional fidelity is required, condenser microphones are used. A condenser microphone consists essentially of a high grade condenser of very small capacity, of which one plate is rigid and the other is a tightly stretched diaphragm. It operates on a different principle from that of a carbon microphone. A high voltage polarizing battery E, Fig. 86, is used to charge the condenser through a very high resistance R1. When sound waves fall on the diaphragm of the microphone condenser M, the capacity changes. When it increases current flows into the condenser through R1, and when it decreases current flows out through the same resistance. That is, when the diaphragm vibrates an alternating current flows through R1. The alternating voltage drop in R1 is impressed on the grid of an amplifying tube, either directly or through a condenser C and a grid leak R2. R3 in this circuit is a ballast which maintains the grid of the tube negative.

Extreme precautions must be taken to prevent any leakage current through the insulation of the microphone. If there is considerable leakage the low notes will not be reproduced in their true proportion. The resistance connected across the microphone must also be exceedingly high if the low notes are to be picked up as efficiently as the high. In practice the total effective resistance may be as high as 50 megohms, which indicates that the insulation of the condenser must be of a very high order.

Because of the necessity of a high resistance across the microphone it may be better to omit C and R2 and couple the microphone by means of R1 alone. The grid of the tube must be kept negative because any grid current would indicate a comparatively low resistance shunted across the microphone.

It is customary to mount the first amplifier tube as near the microphone as possible in order that leakage between leads may be reduced to a minimum.

While the output in the case illustrated in Fig. 86 is a transformer, this could well be a resistance coupler.

Condenser microphones also come in push-pull. A circuit for such a microphone is illustrated in Fig. 87. All precautions mentioned in connection with the single microphone in Fig. 86 apply with equal force to this circuit. It is clear that the stopping condensers and the grid leaks can be omitted if the negative terminal of the grid bias battery E2 is connected to the positive terminal of the microphone polarizing battery E1.

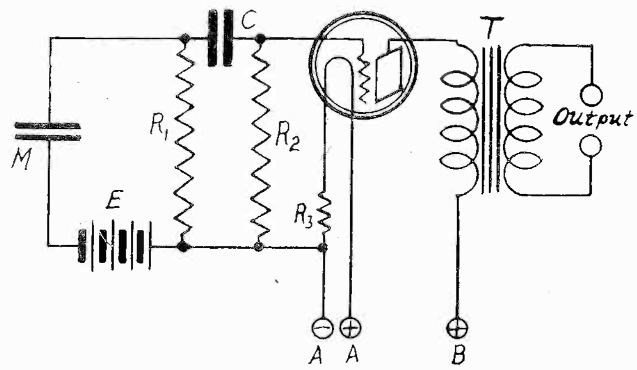

FIG. 86.

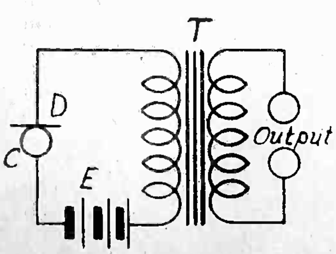

FIG. 84

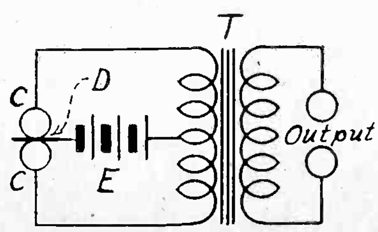

FIG. 85.

Photo-Electric Input

In many amplifiers the input signal is derived from a photo-electric cell. This is the case wherever the signal at one stage consists of light intensity variations, as in talking motion pictures in which the sound signal is recorded on the film, in certain types of phonographs in which the sound is also recorded on a film, in the transmission of still and moving pictures, in the transmission of television images, and in photo-telephony.

The connection of the photo-electric cell to the amplifier is not unlike the connection of the condenser microphone. A polarizing battery on the photo-electric cell is necessary, which serves the same purpose as the B battery in ordinary amplifier tubes. Indeed, the B battery can be used for the photo-electric cell at the same time it is used for amplifier tubes.

In Fig. 88 is shown one connection of a photo-electric cell to an amplifier tube. PC is the photo-electric cell into which the signal-modulated light enters. E is the polarizing battery and R1 is the load resistance. The fluctuating light produces a fluctuating current through this resistance and the resulting voltage drop is impressed on the grid of an amplifier tube, in this instance through the stopping condenser C and the grid leak R2. The use of C and R2 is for the purpose of establishing a definite grid bias on the tube, which in this case is the drop in the ballast resistance R3.

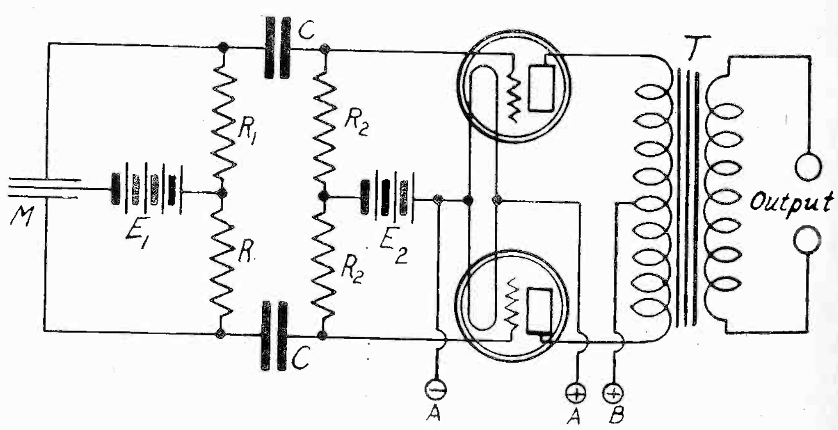

FIG. 87.
THE CONNECTION OF A PUSH-PULL CONDENSER TYPE MICROPHONE TO A PUSH-PULL AMPLIFIER.

It is not necessary, however, to use C and R2, as shown in Fig. 89. In this circuit the grid is maintained at a suitable negative potential with respect to the filament by means of a grid battery E. In this circuit, also, the B battery is used for polarizing the photo-electric cell, but a separate battery could be used just as well.

Resistance couplers follow the circuits in Figs. 88 and 89 because in nearly all cases where a photo-electric cell is used it is necessary to amplify low frequencies as well as the high. Indeed, in some cases it is necessary to amplify so-called direct current. Where telephonic frequencies only are involved a transformer could follow the amplifier tube in either of the circuits in Figs. 88 and 89.

The output binding posts in Figs. 88 and 89 can be connected to PU terminals in Figs. 78 to 81, inclusive.

NEW 228 TUBE

Additional Curves for High Mu AC Valve

By J. E. Anderson

Technical Editor

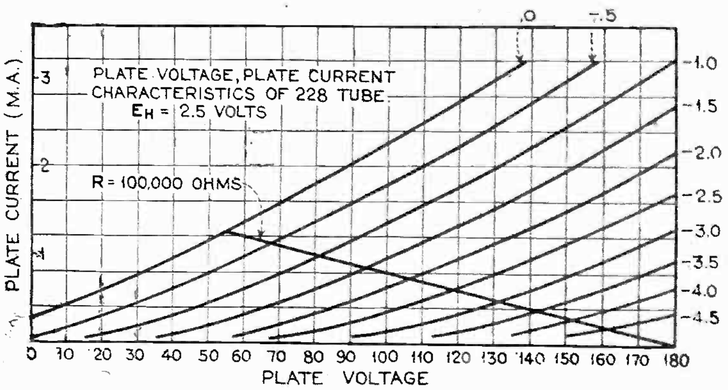

FIG. 1.
PLATE CURRENT, PLATE VOLTAGE CHARACTERISTICS OF THE 228 HIGH MU HEATER TUBE.

LAST week was published for the first time announcement of the new 228 heater type high mu tube, with characteristic curves. The two curves then given were for no load on the tube and for a load resistance of 100,000 ohms, and both curves gave the relationship between grid voltage and the plate current.

It is now customary to give also a family of plate voltage, plate current curves to show the performance of the tube under varying conditions; because from such a family of curves it is possible to obtain the plate current for different effective plate voltages, grid voltages and plate load resistances. These curves also provide a quick method of obtaining the voltage amplification for any given load resistance.

Because of the usefulness of these curves we herewith publish a family of plate voltage, plate current curves for a range of grid voltages from zero to 4.5 volts negative and a plate voltage range from zero to 180 volts positive.

Amplification Factor Varies

As was pointed out last week, the amplification factor varies to some extent, a fact which is true for all tubes. The family of curves herewith also shows this variation of the amplification factor. Take, for example, the line representing a current of 2.8 milliamperes and note the plate voltages where the various curves cross this line. The zero bias line crosses the selected current line at 123 volts. The —.5 line crosses the current line at 143 volts. The difference is just 20 volts. Since this change was produced by a grid voltage change of ½ volt, the amplification factor is 40. The —1.0 line crosses the same current line at 163.5 volts. The difference between the two voltages is now 163.5—143, or 20.5, giving a value of 41 for the amplification constant. That these values should be smaller than the values obtained for small changes of plate voltage is to be expected. Last week the amplification "constant" was given as 45, which was a mean value obtained by changing the plate voltage by 7.5 volts.

The amplification factor itself is not so important as the voltage amplification that can be obtained from the tube in a given circuit. This amplification can be obtained very simply from the family of curves. The load line drawn across the curves is for a resistance of 100,000 ohms, as indicated, and a plate battery voltage of 180 volts. What is the voltage amplification between zero bias and a bias of 4.5 volts? The load line crosses the zero bias line at 54 volts effective plate voltage. It crosses the curve for 4.5 volts bias at 161.5 volts. The difference, which is the drop in the resistor, is 107.5 volts. Since this is produced by a grid voltage change of 4.5 volts, the amplification is 23.9.

If necessary it would be possible to use a bias as great as 5 volts without much distortion. While the curve for a bias of 5 volts is not given, it crosses the load line at 171 volts. Therefore between zero bias and 5 volts the amplification is 23.4. There is evidently some distortion or the two values would have been the same, but as they do not differ much, the distortion is small.

If the tube is to be operated under these conditions the fixed grid bias should be 2.5 volts. At this point the plate current is nearly .6 milliampere, and the effective plate voltage is 119 volts. While this would allow a signal amplitude of 2.5 volts, it would be better not to use more than 2.25 volts. This would make the amplitude of the signal drop in the load resistor 53 volts, which is ample to load up a 245 tube. Now if grid bias detection is used it is possible to get more than 2.25 volts out of the detector, so that only one amplifier tube is needed between the detector and the power tube.

If somewhat better quality is desired a plate load resistance of .2 or .25 megohms should be used. If .2 megohm be used the amplification will be raised to nearly 28 times. The maximum voltage amplitude in the coupling resistor will be nearly 70 volts. This is more than enough to load up a 245 tube. A negative bias of 2 volts would be sufficient in this case. This would give a steady current of about .5 milliampere.

If the plate load resistance be .25 megohm, the amplification will be 29, with a smaller percentage of distortion than when the load is 100,000 or 200,000 ohms.

Used Ahead of a 250

When the tube is used ahead of a 250 power tube, 180 volts in the plate circuit are not enough. It should be raised to at least 225 volts and be applied through a load resistance of .25 megohm. This will allow loading up the power tube to the maximum without appreciable distortion. The negative bias in this instance should be slightly less than 3 volts. Even when the 228 tube precedes a 250 power tube, a grid bias detector will deliver sufficient signal voltages to load up the circuit provided that 225 volts or more are used on the 228 and the load resistance is .25 megohm or higher. Hence it is not necessary to use more than two tubes in the amplifier.

As an amplifier having three plate circuits on the common voltage supply is very unstable, exceptional precautions must be taken to minimize feedback through the common impedance. For a discussion of this subject the reader is referred to the August 10th issue of RADIO WORLD.

Used as a Detector

The performance of this tube as a grid bias detector is not shown in the family of plate voltage, plate current curves published herewith, because detection depends on the departure of the curves from straight lines, especially near the plate voltage axis. The detection effect is shown much better on the grid voltage, plate current curves last week. There it appears that best detection is obtained when the grid bias is 4 volts negative. This is for a load resistance of 100,000 ohms and a plate battery voltage of 135 volts.

Taking the amplification factor into consideration, the best bias for detection when the plate battery voltage is 180 volts would be 5 volts negative. Likewise when the plate battery voltage is 220, the bias for detection would be 6 volts negative.

The bias does not depend appreciably on the value of the load resistance, either for detection or amplification.

Too Much Bias in First Stage

AFTER having installed a 171A power tube in my battery-operated receiver, where the last tube formerly was a 201-A, I find the tone is not nearly as clear. My receiver has a radio frequency amplifier, condenser-and-leak detection, and two stages of transformer-coupled audio.—J. H. D.

The wiring of receivers of the type of yours usually provides a common C minus lead for the first and second audio stages. Therefore, although you retained a 201A as first audio amplifier at the usual plate voltage, say, 90 volts, the change in the last-stage bias for the new power tube, to about 40.5 volts negative, biased the first audio tube to the same extent. This is enormously wrong. Cut the C lead that is common to the grid circuits of the two audio stages, so that the first stage can go to 4.5 volts negative, as formerly, while the last stage alone gets the high bias. Then the tone will be clear.

WORTH THINKING OVER

THE person who can listen in on the radio these times and not get some better understanding of the culture that comes with good music must be like the girl who, when shown the tempestuous beauty and inspiring grandeur of Niagara Falls remarked gleefully: "How cute!"

REACTIVATION OF T

Flashing, with No Plate Voltage, Restore

By Gush

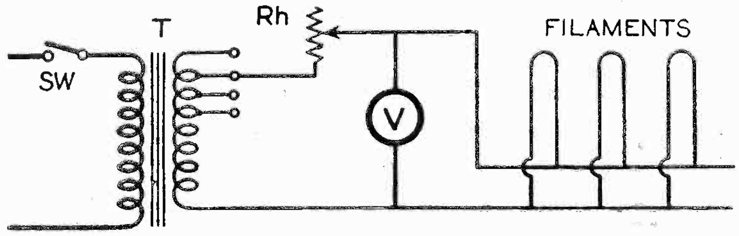

FIG. 1
A CIRCUIT FOR FLASHING TUBE FILAMENTS DURING REACTIVATION.

Although new vacuum tubes are comparatively inexpensive, there is a great deal of interest in reactivation of "paralyzed" tubes. In most instances a "paralyzed" tube is simply a dead tube, and any attempt to revive it is usually wasted time and effort. However, there are cases in which the tube is only suffering from suspended activity, and in such cases the reactivation process may restore the tube to another period of usefulness. Only the thoriated tungsten filament tubes can be reactivated under any conditions.

The thoriated tungsten filament is made of a mixture of pure tungsten and a small quantity of thorium oxide. The heating of the filament reduces the thorium oxide near the surface of the conductor to pure thorium, the thickness of the layer of thorium being only about one molecule. The presence of the thorium has the property of releasing electrons more readily than tungsten, and it is for this reason that filaments of this type are operated at a much lower temperature than filaments of pure tungsten.

The metallic thorium on the surface of the tungsten continually evaporates as the tube operates. The thorium that is thus liberated is replaced by the reduction of the supply of thorium oxide in the interior of the filament, that is, by the conversion of the oxide to the pure metal. Normally this process is gradual. When all the oxide has been reduced and all the thorium evaporated, the tube is dead beyond the possibility of reactivation.

A Paralytic Stroke

Sometimes a tube is subjected to abuse, for example, the application of an excessive plate voltage. This may cause the surface layer of thorium to be evaporated without any replacement from within. The tube is then apparently dead or paralyzed. If the "paralyzing" shock was not too great, it is possible to revive the tube in this case, for their is still a quantity of thorium oxide in the filament which can be reduced to metallic form on the surface of the tungsten provided the proper process be applied.

The following tubes have thoriated filaments: UX-199, UX-120, UX-200A, UX-201A, UX-222, UX-240, UX-171 and UX-210, and the corresponding tubes of the CX type. In addition to these amplifier tubes, the two rectifiers 213 and 216-B have thoriated filaments.

The reactivation process consists of two parts, the flashing and the burning. Both of these are required in reactivating a tube which has been abused greatly; only the second need be applied if the tube has been overloaded but slightly.

The purpose of the flashing is to clean the surface of the tungsten filament, to remove all impurities on the surface. This is done by operating the filament for a period of from 10 to 20 seconds at a high temperature so that any impurities, including any thorium, is actually boiled off. In effect this completely paralyzes the filament, but leaves it in a condition for the formation of a new and clean thorium layer from the thorium oxide that is still left in the interior. The filament terminal voltage for flashing depends on the normal terminal voltage of the tube in question, and is approximately three times as great. The actual values for the various tubes are given in the table herewith.

The Burning Process

The burning process consists of operating the filament for a certain period at a terminal voltage about 20 per cent. higher than the normal operating voltage. The exact burning voltage for each tube is also given in the table. The length of the

Type of tube	Filament — Emission test	Bu
199	3.3	4.
120	3.3	4.
222	3.3	4
201A	5.0	7
201B	5.0	7
200A	5.0	7.
240	5.0	7.
171	5 0	7.
210	6.0	9.
213	4.0	6
216B	6.0	9.

burning period depends on the tube and on its condition. It is first burned for a period of 30 minutes. Then a test is made of its filament emission. If the emission current is less than the minimum current given in the attached table for the tube in question, the filament is burned for another period of 30 minutes and another emission test is made. It may require a total of 1.5 hours for complete reactivation, or the first period of 30 minutes may be sufficient. If no improvement in the emission current is shown after a few thirty-minute periods of burning, the tube can be considered dead.

If the burning was done without first flashing the tube and no improvement is shown with the continued burning, the filament should be flashed before abandoning hope of reactivation.

Emission Test

During the emission test the tube is operated as a rectifier, the grid and the plate being tied together. The rectifier 213 has two filaments which may be in different conditions. Therefore

Right or

[Herewith are ten questions. They are propounded from articles published in last week's issue, August 31st. If you read that issue carefully, then you should be able to answer all ten questions accurately. Read this week's issue from cover to cover and you will know the answers to next week's questions even before the questions ar put.—Editor.]

* * *

(1).—When a screen grid tube is operated in a resistance coupled circuit, the applied plate voltage should be increased to offset the voltage drop in the coupling resistor and the screen voltage should be decreased.

(2).—An electrolytic condenser of large capacity should be connected across the output of a rectifier next to the tube for best results.

(3).—A screen grid tube in an amplifier is of no advantage because only a small fraction of the amplification factor can be utilized.

(4).—If a high mu tube has a low internal plate resistance it is feasible to couple it to the next tube by means of a transformer.

(5).—If a family of plate current, plate voltage curves is available for a power tube it is possible to calculate the amount of second harmonic distortion which will result when a given signal is impressed on the tube.

(6).—The grid bias on a tube can be determined by measuring the plate current in the tube with a known voltage on the plate.

(7).—In a screen grid tube the plate current flows in the same direction for all plate voltages just as in a three-element tube.

(8).—In a screen grid tube the screen current remains constant and is always less than the plate current.

(9).—Grid current never flows in a tube when the grid is negative with respect to the filament of the cathode.

(10).—When a vacuum tube is used as a grid bias detector for large signals the detected signal is substantially proportional to the radio frequency signal and not proportional to the square of the carrier amplitude.

ORIATED FILAMENTS

ost Emission—Over-Heating Also Used

Quirk

Flashing	Plate voltage emission test	Minimum emission current (ma)	Filament Resistance (Ohms)
12.0	50	6	50
12.0	50	15	25
12.0	Test as amplifier		25
16.0	50	25	20
16.0	50	25	20
16.0	50	12	20
16.0	50	25	20
16.0	50	50	20
16.0	100	100	10
16.0	100	50 (per filament)	2.5
16.0	125	100	6

r of the filaments should be reactivated and tested indi-dently of the other. That is, the tube is tested as if it were different tubes.

he source of the flashing and burning voltages may be either ttery or a transformer. For flashing a B battery of the re-ed voltage might well be used since the duration of the n is very short, and hence very few milliampere-hours will taken from the battery. For burning it is necessary to use age batteries or a suitable transformer, except that the ll dry cell tubes may be burned with dry cells.

Whenever it is possible to use a transformer for flashing burning this is recommended. Inexpensive toy transform-having the required voltages are available and can be pur-sed in almost any electrical store. If the voltage taps are exactly those required for a given operation and a given , a rheostat can be inserted in series with the filament or nents for adjusting the voltage to the required value. Fig. ows the circuit for the flashing operation, using a trans-ner as the voltage source and Fig. 2 shows the connection

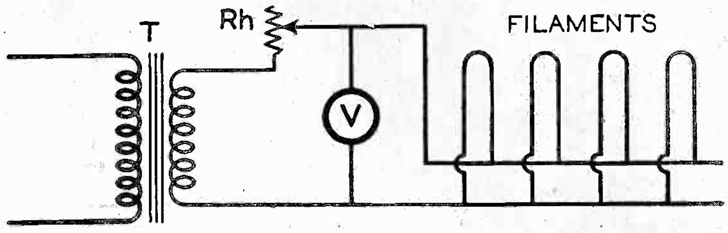

FIG. 2
AN ARRANGEMENT OF CIRCUIT FOR BURNING THE FILAMENT DURING REACTIVATION.

for the burning operation. Essentially the two circuits are the same, differing only in the voltage indicated by the voltmeter across the filament line. Fig. 3 shows the emission test circuit, V being the voltmeter which measures the emission test filament voltage and *ma* the milliammeter which indicates the emission.

To make the process of reactivation clear, let us take a UX-120 tube as an example. The test circuit is arranged as in Fig. 1, with a 25-ohm resistor in place of the filament. Turn on the power and adjust the taps on the transformer and the setting of the rheostat until the reading of the AC voltmeter is 12 volts, the flashing voltage given in the table. Then open the switch, remove the 25-ohm resistor and put the filament of the 120 tube in its place. Get a watch ready for timing the flash. Turn on the power for 10 or 20 seconds. A longer flash will probably vaporize the filament and end the operation.

If the filament survives the flashing operation readjust the circuit so that the voltage indicated by the AC voltmeter is 4 volts, the burning voltage given in the table for the tube in question. Leave it burning at 4 volts for 30 minutes.

At the expiration of this burning period, put the tube in circuit shown in Fig. 3 and measure the emission current. The filament voltage now should be 3.3 volts and the plate voltage should be 50 volts. If now the emission current, that is, the combined grid and plate current, is more than 15 milliamperes, the tube may be considered reactivated. If it is less than this, return the tube to the burning circuit, Fig. 2, for another 30-minute period. Test again on circuit in Fig. 3. Continue until the total burning period is 1.5 hours, or until the emission current is greater than 15 milliamperes.

Burn-out Danger

As some of the filaments may burn out completely during the flashing process, it may be well to attempt to restore a tube first to the burning operation alone. If it cannot be restored by this method alone, it has been greatly damaged and very little is lost if the filament does go during a flashing operation.

The last column in the table gives the hot resistance of the filament of the tube. This is included in order that a resistor of the indicated value may be connected across the filament line while the flashing volt is adjusted.

The taking of an emission test with the circuit in Fig. 3 should be done quickly, for nothing is gained by letting current flow for a considerable period. It only shortens the life of the tube, and may defeat the purpose of the reactivation. In order to shorten the time that current flows, the battery E should be left disconnected until everything is ready for a reading. Then contact should be made just long enough to observe the reading on the meter MA.

Whenever it becomes necessary to buy a new tube because an old one cannot be reactivated, it is best to get one which cannot be reactivated at all. It has a longer life. Of course, there are a few tubes which cannot be had except in the thoriated tungsten filament. When a new tube of this type is purchased it is well to remember that it can readily be "paralyzed" by abuse, that is, by the application of too high plate voltages and too low grid voltages.

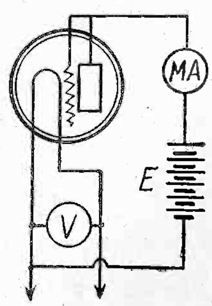

FIG. 3
WHEN TAKING AN EMISSION TEST ON THE TUBE THE PLATE AND THE GRID SHOULD BE CONNECTED TOGETHER.

/rong?

).—Right. This is correct for a screen grid tube, for this will not function properly if the effective voltage on the plate ss than the screen grid voltage. In a three-element tube it is necessary to increase the battery voltage, unless the amplitude ne signal demands it.

).—Wrong. If the condenser next to the rectifier tube is the tube is subjected to heavy strains. Also, the filtering be much poorer than if a smaller condenser is used.

).—Wrong. The main object of using a tube is not to get maximum amplification that tube is capable of but to get a amplification from the tube and the circuit. The screen grid will yield a higher amplification than any other tube, even if a small fraction of its amplification constant is utilized.

).—Right. The mu of the tube has nothing to do with the of coupling that follows the tube. If the internal impedance of tube is so low that it is small compared with an audio trans-er primary impedance, it is all right to use a transformer.

).—Right. The output power can be calculated from the es by assuming the curves are straight lines. The second nonic distortion can be calculated by taking into account the that the curves are not straight.

).—Right. The tube can be used as a vacuum tube voltmeter.

).—Wrong. For certain voltages on the plate the plate cur-is negative, a fact which can be seen from the family of curves ig. 77, page 14, August 31st issue of RADIO WORLD.

).—Wrong. The screen grid current varies and is in opposite e to the plate current. This also can be seen from the curves red to.

).—Wrong. For low values of negative grid bias there is a l grid current, but this decreases rapidly as the negative bias ases. If the tube is gaseous, there may be considerable grid ent.

0).—Right. That is the reason modern receivers are said to linear detection. The linearity of the response is better, the r the signal up to a certain limit which is usually not met in ical cases.

RADIO UNIVERSITY

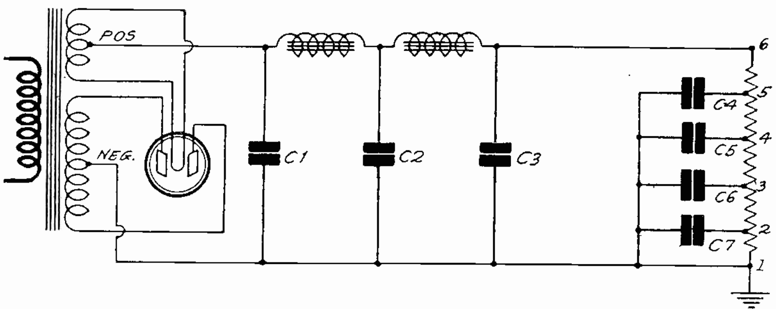

FIG. 782
DIAGRAM OF SIMPLE B SUPPLY.

Summary of HB Compact Advice

PLEASE summarize the mechanical and electrical precautions for the construction of the HB Compact, battery model, described in the August 24th and 31st issues.—H. R.

The precautions are: (1) Mount the coils on the front panel. If Screen Grid Coil Company's models are used no insulation is necessary between the shaft and the front panel, where the steel cabinet is used, but if National Company coils are used, insulation is necessary. If an insulation front panel is used, e.g., hard rubber or bakelite, no other insulation at all is necessary. (2) Put a flexible coupler on the shaft protruding at rear of each coil, and mount the tuning condenser so that its shaft points toward the front panel, but fits into the open side of the flexible coupler or link. (3) Insulate the rheostat if a metal panel is used, otherwise not. (4) If a metal subpanel is used with metal cabinet, use these as grounded A minus, and pick up the A minus lead for circuit connections at the most convenient points from the subpanel, otherwise (as where a baseboard is used), be sure to connect all leads calling for grounded A minus, to the ground binding post, which you start off with as A minus and ground. (5) If the aluminum subpanel is used with steel cabinet, and the socket hardware protrudes downward from bottom a little more than room allows, due to lugs pointing straight down, *bend back the lugs with fingers or pliers,* so they will clear the half-inch space allowed. The lugs are so constructed as to facilitate this bending. (6) Insulate two main condenser brackets and six auxiliary condenser brackets.

* * *

His Radiator a Good Aerial

IN my home I may use the outdoor aerial and radiator ground, or I may ignore the aerial, and connect the radiator lead to the antenna post of the receiver. In either instance I get about the same results in reception. I wonder if it would be all right, therefore, to use the radiator as aerial and dispense with any ground connection.—D. E. R.

Yes. In some locations this condition prevails, due to the ground lead being at a relatively high radio frequency potential. It is a common occurrence in apartment houses, particularly on the upper floors, and in taller buildings.

* * *

Lining Up a Gang Condenser

PLEASE explain an easy way to line up a gang condenser where there is an equalizing condenser across each tuning section of the main condenser.—H. F.

The ear test, or listening test, is one often used. A station is tuned in and the equalizers are adjusted until volume is greatest. Preferably a low wavelength station should be tuned in. The human ear does not appreciate changes in volume unless they exceed 25 per cent., but as wrong adjustment of the equalizers will decrease the volume much more than that, approximately correct adjustment will be possible by the listening test. A better way is to put a 0-25 or similar milliammeter in series with the detector plate lead, just as a precautionary determination of how much plate current is flowing, and then substitute a milliammeter of greater sensitivity, one that reads at a maximum deflection somewhat more than the reading provisionally obtained. This meter should not be more than 0-5 ma. Then the equalizer adjustments may be made on the basis of the detector plate current reading If negative grid bias detection is used, the plate current will increase as the signal increases, while by the leak-condenser method the plate current will decrease as the signal increases. Hence the adjustments are correct when the plate current reads highest by the negative grid bias method and lowest for the leak-condenser method.

* * *

AC Power for 3.3 Volt Tubes

IS it possible to power a receiver using 199 and 120 tubes, omitting batteries at present in service?—G. D.

Yes. Use a 4.5-volt A eliminator, and a 135-volt B eliminator that has suitable intermediate B voltage taps. Usually C batteries serve biasing purposes even in an electrified installation like this one. It is assumed you have AC house lighting supply. Be sure the supply is 110 volts, 50-60 cycles, if the A and B eliminators are designed for such primary voltage and frequency, as nearly all of them are.

* * *

Cure for Motorboating

A RESISTANCE-COUPLED audio amplifier in a receiver that I built motorboats, and therefore I am considering using some factory made radio frequency coils designed for the circuit, instead of home-made coils at present in use.—U. T.

The radio frequency coils have nothing to do with this condition of audio oscillation or audio regeneration called motorboating. Try reducing the values of the plate coupling resistors and grid leaks, particularly the grid leaks. Also use a large capacity, as afforded by Mershon condensers, to bypass the B plus voltages, both intermediate voltages and power tube voltage. These two remedies almost always cure the ill. The only common exception is where the choke coils used in the filter circuit of an AC type B supply have too high a resistance. If yours is an AC circuit, try using only one choke coil, and put a 2 mfd. paper dielectric condenser next to the rectifier, and a large capacity, 18 mfd. or more, even 36 mfd., at the other side of the choke coil.

* * *

Why I^2R Equals the Wattage

I HAVE studied Ohm's law, and understand it so far as it has come under my observation, but I do not understand why the current squared, times the resistance, equals the wattage.—G. H.

It is simply a statement in substituted terms of the definition that the current times the voltage equals the wattage. Thus, as $i \times e$=wattage, by Ohm's law you can substitute for the voltage e, the expression $i \times r$. Hence $i \times e$, representing wattage, becomes $i \times (i \times r)$ or $i^2 r$=wattage. It is customary to use small letters, i, r, e, etc., to designate variable voltages, while capital letters, I, R, E, are used if effective voltages are under discussion.

* * *

A Simple B Supply

PLEASE show a diagram of a simple B supply, using 280 tube, and give data on voltage divider.—F. J. R.

The diagram is published herewith as Fig. 782. A 5-volt winding heats the rectifier tube. The other winding is high voltage, about 350 to 375 volts across each half of the secondary, 700 to 750 across entirety. C1 is 2 mfd., C2 is 2 mfd. or higher capacity, C3 is as high as you can get. The output voltage divider points (1) to (6), may be a 10,000-ohm 50-watt resistor with four sliders, so you can get what voltage values you desire. The by-pass condensers are 2 mfd., except whatever one you use for bypassing the last audio biasing resistor. This capacity should be 4 mfd.

* * *

Use of Different Types of Cabinet

WHERE a metal cabinet is prescribed for a receiver, is it just as well to use a wooden cabinet, with a bakelite front panel, or must one use the steel cabinet?—H. G. S.

The type of cabinet is immaterial. You may use what you have or what you prefer. Where a metal cabinet is prescribed it is usually because of its compactness and physical suitability for the receiver, as well as for economical reasons, since the front panel is a part of the cabinet.

High or Low Ratio for RF?

WHAT ratio do you propose for coupling a tuned primary screen grid circuit to a detector, where the secondary is untuned?—K. H. D.

The ratio must be determined on the basis of the circuit design and this ratio has much to do with the performance. If you want more volume of course use a higher ratio than otherwise, say 1-to-1½ tuned primary to untuned secondary, with close coupling. For greater selectivity a stepdown ratio may be used or looser coupling. The capabilities of the screen grid tube are best proved by a tuned primary, with step-up ratio to the next stage, and the circuit design should be good enough to enable this to be done, even where few tubes are used. In multi-tube circuits, of course, the overall gain is so great that individual stage gain need not be so high. See the HB Compact for battery operation, described in this issue, as an example of a high-gain circuit of the type that interests you.

* * *

Interested in HB Compact

MY attention was attracted to the HB compact as a four tube receiver design for battery operation that promises to excel. I therefore ask you kindly to inform me where I can get a template of the layout of parts or, preferably, a blueprint. I should like to build this tempting receiver at once.—E. W. S.

See the pictorial wiring diagram, published full size, on pages 12 and 13 of last week's issue. Also read the second instalment of the constructional article, published on pages 12 and 13 of that issue. You will not need a blueprint, of course, as the pictorial diagram is, so to speak, a "blueprint printed in black.

* * *

Coil Efficiency Discussed

PLEASE clear up some points on coils for radio frequency. Is it true that coils with a small field, such as doughnut or toroid coils, are more efficient? What is the most suitable diameter for any coil? Is there any advantage in space winding?—H. S. A.

The subject of coil design can not always be dissociated from the particular circuit in which the coils are to be used, as sometimes a less efficient coil solves problems that arise only if a more efficient coil were used. It is certainly untrue that coils with smaller external fields, like toroids, are more efficient. Indeed, it is exactly true to state that the measure of a coil's efficiency is the extent and strength of its field. The only positive asset a coil has is its field, hence the field is its figure of merit, much more so, by the way, than the mutual conductance is a tube's figure of merit. Toroids require much more wire to attain a given inductance than do solenoids, hence toroids have a higher radio frequency resistance, and this effect is sometimes capitalized to produce stabiltiy. But it is resistance directly in the tuned circuit, so has little to commend it, grid suppressors with more efficient coils being preferable. In general, there is no known type of coil superior to the solenoid. What the diameter should be depends on the number of turns of a given tvpe of wire and insulation, since the axial coil length should be about one-and-a-half times the diameter. But variations from this formula are entirely permissible even small-diameter, long length coils being acceptable, especially in modern circuits where the sensitivity of cascaded RF stages is very high, and the selectivity adequate, due to the number of stages. Space winding reduces the distributed capacity, hence is valuable where circuit constants and design may make it otherwise difficult to cover a given band of frequencies, as the broadcast band, using a small capacity condenser (.00025 mfd.) Another advantage is that space winding, being usually done in grooved forms, makes possible greater uniformity of inductance in quantity production.

* * *

Listens In to Television

ONCE in a while on my short-wave set I pick up television signals. These I recognize by their peculiar grinding sounds, a grind produced as if from some whirling motor. Please let me know what it is I hear.—F. S.

You hear the sounds to which the vision has been converted, plus the sound of the motor driving the scanning disc. This motor sound is extraneous and is a form of interference, although it need not necessarily have any bad effect upon the picture. When a moving object is televised, the image is scanned, and the resultant intermittent and graduated light is impressed on a photo-electric cell. This has the property of producing changes in current values equivalent to changes in light values. These changing current values are amplified and many of them are audible. The changes are impressed on a radio frequency wave, this constituting the act of modulation, and the modulated wave is transmitted in the usual way. At the receiving end a set is tuned to the signal frequency, and the transmission process is reversed, so the image can be seen. That is, the radio wave is tuned in, the carrier eliminated, by detection, the audio component amplified in the AF channel, the output fed into a kino lamp which produces values of light corresponding to the values of current, and these light values a scanning disc picks up. Concentration of this controlled light, through the disc holes to a small screen, completes visibility.

* * *

Voltage Divider for B Supply

I AM in doubt as to what type and wattage of voltage divider to use in my B supply.—G. H.

The problems of output voltages are easily solved by using a resistor with adjustable taps. Then with the aid of a high resistance voltmeter, 1,000 ohms per volt, you can establish the desired voltages by moving the taps and finally tightening the moving part. For ordinary purposes, using a B supply for 245 tube, single-sided output, a 10,000 ohm resistor would be satisfactory, rated at 50 watts. If push-pull is used either the wattage of the entire resistor should be raised, say 50 per cent., or the wattage of the biasing section, through which flows the current of the last audio push-pull tubes, should be 75 watts. It is this section that carries the extra current due to push-pull. The rating, of course, is higher than the actual wattage, but this is as it should be. The resistance of the total voltage divider determines the bleeder current at specified voltage. Hence at 300 volts, with 10,000 ohms total, the bleeder is 30 ma. It is well to have a substantial bleeder like this, to stabilize the output voltages, making them stand up better as more plate current is drawn, due to the extra number or different type of tubes and couplings used.

* * *

Reason for Selectivity Difference

THE short-wave receiver I built, to cover the broadcast band as well. I find enough selectivity on the short wavelengths but not enough selectivity on the higher wavelengths (broadcast spectrum). I am satisfied with the receiver, as it was built primarily for short-wave reception, and the broadcast wave feature is purely incidental, and welcome as that much extra service. But I would like to know the reason for this phenomenon of differentiated selectivity. I use plug-in coils. Two coils for the broadcast band require throwing a switch to increase the tuning capacity by parallel condenser connection.—T. Y.

The reduced selectivity on the broadcast band is due to the reduced ratio of inductance to capacity. For best results the ratio of inductance to capacity should be high. This high ratio is not quite feasible in such a receiver as yours, hence the results on the broadcast band must be accepted as they are, merely fair, while reliance for best work is placed on the receiver when it is functioning on the short waves.

REACTIVATION OF T

Flashing, with No Plate Voltage, Restore

By Gus

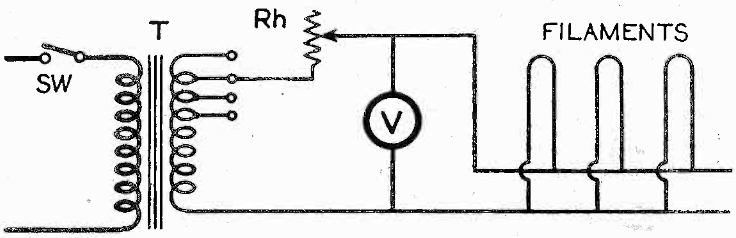

FIG. 1
A CIRCUIT FOR FLASHING TUBE FILAMENTS DURING REACTIVATION.

Although new vacuum tubes are comparatively inexpensive, there is a great deal of interest in reactivation of "paralyzed" tubes. In most instances a "paralyzed" tube is simply a dead tube, and any attempt to revive it is usually wasted time and effort. However, there are cases in which the tube is only suffering from suspended activity, and in such cases the reactivation process may restore the tube to another period of usefulness. Only the thoriated tungsten filament tubes can be reactivated under any conditions.

The thoriated tungsten filament is made of a mixture of pure tungsten and a small quantity of thorium oxide. The heating of the filament reduces the thorium oxide near the surface of the conductor to pure thorium, the thickness of the layer of thorium being only about one molecule. The presence of the thorium has the property of releasing electrons more readily than tungsten, and it is for this reason that filaments of this type are operated at a much lower temperature than filaments of pure tungsten.

The metallic thorium on the surface of the tungsten continually evaporates as the tube operates. The thorium that is thus liberated is replaced by the reduction of the supply of thorium oxide in the interior of the filament, that is, by the conversion of the oxide to the pure metal. Normally this process is gradual. When all the oxide has been reduced and all the thorium evaporated, the tube is dead beyond the possibility of reactivation.

A Paralytic Stroke

Sometimes a tube is subjected to abuse, for example, the application of an excessive plate voltage. This may cause the surface layer of thorium to be evaporated without any replacement from within. The tube is then apparently dead or paralyzed. If the "paralyzing" shock was not too great, it is possible to revive the tube in this case, for their is still a quantity of thorium oxide in the filament which can be reduced to metallic form on the surface of the tungsten provided the proper process be applied.

The following tubes have thoriated filaments: UX-199, UX-120, UX-200A, UX-201A, UX-222, UX-240, UX-171 and UX-210, and the corresponding tubes of the CX type. In addition to these amplifier tubes, the two rectifiers 213 and 216-B have thoriated filaments.

The reactivation process consists of two parts, the flashing and the burning. Both of these are required in reactivating a tube which has been abused greatly; only the second need be applied if the tube has been overloaded but slightly.

The purpose of the flashing is to clean the surface of the tungsten filament, to remove all impurities on the surface. This is done by operating the filament for a period of from 10 to 20 seconds at a high temperature so that any impurities, including any thorium, is actually boiled off. In effect this completely paralyzes the filament, but leaves it in a condition for the formation of a new and clean thorium layer from the thorium oxide that is still left in the interior. The filament terminal voltage for flashing depends on the normal terminal voltage of the tube in question, and is approximately three times as great. The actual values for the various tubes are given in the table herewith.

The Burning Process

The burning process consists of operating the filament for a certain period at a terminal voltage about 20 per cent. higher than the normal operating voltage. The exact burning voltage for each tube is also given in the table. The length of the burning period depends on the tube and on its condition. It is first burned for a period of 30 minutes. Then a test is made of its filament emission. If the emission current is less than the minimum current given in the attached table for the tube in question, the filament is burned for another period of 30 minutes and another emission test is made. It may require a total of 1.5 hours for complete reactivation, or the first period of 30 minutes may be sufficient. If no improvement in the emission current is shown after a few thirty-minute periods of burning, the tube can be considered dead.

If the burning was done without first flashing the tube and no improvement is shown with the continued burning, the filament should be flashed before abandoning hope of reactivation.

Type of tube	Filament — Emission test
199	3.3
120	3.3
222	3.3
201A	5.0
201B	5.0
200A	5.0
240	5.0
171	5.0
210	6.0
213	4.0
216B	6.0

Emission Test

During the emission test the tube is operated as a rectifier, the grid and the plate being tied together. The rectifier 213 has two filaments which may be in different conditions. Therefore

Right or

[Herewith are ten questions. They are propounded from articles published in last week's issue, August 31st. If you read that issue carefully, then you should be able to answer all ten questions accurately. Read this week's issue from cover to cover and you will know the answers to next week's questions even before the questions ar put.—Editor.]

* * *

(1).—When a screen grid tube is operated in a resistance coupled circuit, the applied plate voltage should be increased to offset the voltage drop in the coupling resistor and the screen voltage should be decreased.

(2).—An electrolytic condenser of large capacity should be connected across the output of a rectifier next to the tube for best results.

(3).—A screen grid tube in an amplifier is of no advantage because only a small fraction of the amplification factor can be utilized.

(4).—If a high mu tube has a low internal plate resistance it is feasible to couple it to the next tube by means of a transformer.

(5).—If a family of plate current, plate voltage curves is available for a power tube it is possible to calculate the amount of second harmonic distortion which will result when a given signal is impressed on the tube.

(6).—The grid bias on a tube can be determined by measuring the plate current in the tube with a known voltage on the plate.

(7).—In a screen grid tube the plate current flows in the same direction for all plate voltages just as in a three-element tube.

(8).—In a screen grid tube the screen current remains constant and is always less than the plate current.

(9).—Grid current never flows in a tube when the grid is negative with respect to the filament of the cathode.

(10).—When a vacuum tube is used as a grid bias detector for large signals the detected signal is substantially proportional to the radio frequency signal and not proportional to the square of the carrier amplitude.

HORIATED FILAMENTS

Lost Emission—Over-Heating Also Used

m Quirk

ge— Flashing	Plate voltage emission test	Minimum emission current (ma)	Filament Resistance (Ohms)
12.0	50	6	50
12.0	50	15	25
12.0	Test as amplifier		25
16.0	50	25	20
16.0	50	25	20
16.0	50	12	20
16.0	50	25	20
16.0	50	50	20
16.0	100	100	10
16.0	100	50 (per filament)	2.5
16.0	125	100	6

each of the filaments should be reactivated and tested independently of the other. That is, the tube is tested as if it were two different tubes.

The source of the flashing and burning voltages may be either a battery or a transformer. For flashing a B battery of the required voltage might well be used since the duration of the flash is very short, and hence very few milliampere-hours will be taken from the battery. For burning it is necessary to use storage batteries or a suitable transformer, except that the small dry cell tubes may be burned with dry cells.

Whenever it is possible to use a transformer for flashing and burning this is recommended. Inexpensive toy transformers having the required voltages are available and can be purchased in almost any electrical store. If the voltage taps are not exactly those required for a given operation and a given tube, a rheostat can be inserted in series with the filament or filaments for adjusting the voltage to the required value. Fig. 1 shows the circuit for the flashing operation, using a transformer as the voltage source and Fig. 2 shows the connection

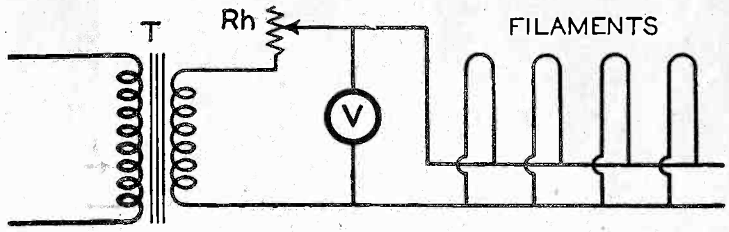

FIG. 2
AN ARRANGEMENT OF CIRCUIT FOR BURNING THE FILAMENT DURING REACTIVATION.

for the burning operation. Essentially the two circuits are the same, differing only in the voltage indicated by the voltmeter across the filament line. Fig. 3 shows the emission test circuit, V being the voltmeter which measures the emission test filament voltage and *ma* the milliammeter which indicates the emission.

To make the process of reactivation clear, let us take a UX-120 tube as an example. The test circuit is arranged as in Fig. 1, with a 25-ohm resistor in place of the filament. Turn on the power and adjust the taps on the transformer and the setting of the rheostat until the reading of the AC voltmeter is 12 volts, the flashing voltage given in the table. Then open the switch, remove the 25-ohm resistor and put the filament of the 120 tube in its place. Get a watch ready for timing the flash. Turn on the power for 10 or 20 seconds. A longer flash will probably vaporize the filament and end the operation.

If the filament survives the flashing operation readjust the circuit so that the voltage indicated by the AC voltmeter is 4 volts, the burning voltage given in the table for the tube in question. Leave it burning at 4 volts for 30 minutes.

At the expiration of this burning period, put the tube in circuit shown in Fig. 3 and measure the emission current. The filament voltage now should be 3.3 volts and the plate voltage should be 50 volts. If now the emission current, that is, the combined grid and plate current, is more than 15 milliamperes, the tube may be considered reactivated. If it is less than this, return the tube to the burning circuit, Fig. 2, for another 30-minute period. Test again on circuit in Fig. 3. Continue until the total burning period is 1.5 hours, or until the emission current is greater than 15 milliamperes.

Burn-out Danger

As some of the filaments may burn out completely during the flashing process, it may be well to attempt to restore a tube first to the burning operation alone. If it cannot be restored by this method alone, it has been greatly damaged and very little is lost if the filament does go during a flashing operation.

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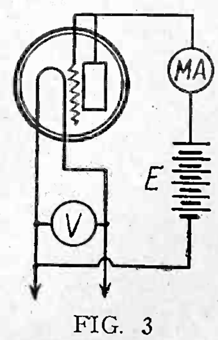
Whenever it becomes necessary to buy a new tube because an old one cannot be reactivated, it is best to get one which cannot be reactivated at all. It has a longer life. Of course, there are a few tubes which cannot be had except in the thoriated tungsten filament. When a new tube of this type is purchased it is well to remember that it can readily be "paralyzed" by abuse, that is, by the application of too high plate voltages and too low grid voltages.



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(3).—Wrong. The main object of using a tube is not to get the maximum amplification that tube is capable of but to get a high amplification from the tube and the circuit. The screen grid tube will yield a higher amplification than any other tube, even if only a small fraction of its amplification constant is utilized.

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(5).—Right. The output power can be calculated from the curves by assuming the curves are straight lines. The second harmonic distortion can be calculated by taking into account the fact that the curves are not straight.

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(9).—Wrong. For low values of negative grid bias there is a small grid current, but this decreases rapidly as the negative bias increases. If the tube is gaseous, there may be considerable grid current.

(10).—Right. That is the reason modern receivers are said to have linear detection. The linearity of the response is better, the larger the signal up to a certain limit which is usually not met in practical cases.

REACTIVATION OF T

Flashing, with No Plate Voltage, Restore

By Gush

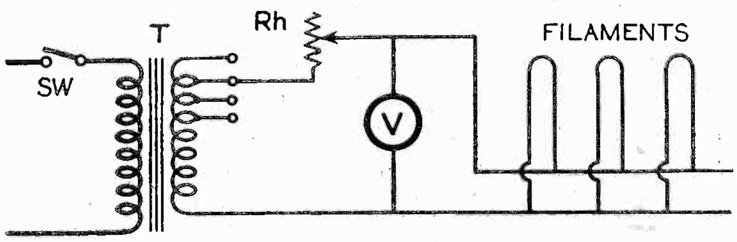

FIG. 1
A CIRCUIT FOR FLASHING TUBE FILAMENTS DURING REACTIVATION.

Although new vacuum tubes are comparatively inexpensive, there is a great deal of interest in reactivation of "paralyzed" tubes. In most instances a "paralyzed" tube is simply a dead tube, and any attempt to revive it is usually wasted time and effort. However, there are cases in which the tube is only suffering from suspended activity, and in such cases the reactivation process may restore the tube to another period of usefulness. Only the thoriated tungsten filament tubes can be reactivated under any conditions.

The thoriated tungsten filament is made of a mixture of pure tungsten and a small quantity of thorium oxide. The heating of the filament reduces the thorium oxide near the surface of the conductor to pure thorium, the thickness of the layer of thorium being only about one molecule. The presence of the thorium has the property of releasing electrons more readily than tungsten, and it is for this reason that filaments of this type are operated at a much lower temperature than filaments of pure tungsten.

The metallic thorium on the surface of the tungsten continually evaporates as the tube operates. The thorium that is thus liberated is replaced by the reduction of the supply of thorium oxide in the interior of the filament, that is, by the conversion of the oxide to the pure metal. Normally this process is gradual. When all the oxide has been reduced and all the thorium evaporated, the tube is dead beyond the possibility of reactivation.

A Paralytic Stroke

Sometimes a tube is subjected to abuse, for example, the application of an excessive plate voltage. This may cause the surface layer of thorium to be evaporated without any replacement from within. The tube is then apparently dead or paralyzed. If the "paralyzing" shock was not too great, it is possible to revive the tube in this case, for their is still a quantity of thorium oxide in the filament which can be reduced to metallic form on the surface of the tungsten provided the proper process be applied.

The following tubes have thoriated filaments: UX-199, UX-120, UX-200A, UX-201A, UX-222, UX-240, UX-171 and UX-210, and the corresponding tubes of the CX type. In addition to these amplifier tubes, the two rectifiers 213 and 216-B have thoriated filaments.

The reactivation process consists of two parts, the flashing and the burning. Both of these are required in reactivating a tube which has been abused greatly; only the second need be applied if the tube has been overloaded but slightly.

The purpose of the flashing is to clean the surface of the tungsten filament, to remove all impurities on the surface. This is done by operating the filament for a period of from 10 to 20 seconds at a high temperature so that any impurities, including any thorium, is actually boiled off. In effect this completely paralyzes the filament, but leaves it in a condition for the formation of a new and clean thorium layer from the thorium oxide that is still left in the interior. The filament terminal voltage for flashing depends on the normal terminal voltage of the tube in question, and is approximately three times as great. The actual values for the various tubes are given in the table herewith.

The Burning Process

The burning process consists of operating the filament for a certain period at a terminal voltage about 20 per cent. higher than the normal operating voltage. The exact burning voltage for each tube is also given in the table. The length of the

Type of tube	Filament — Emission test	B
199	3.3	[illegible]
120	3.3	[illegible]
222	3.3	[illegible]
201A	5.0	[illegible]
201B	5.0	[illegible]
200A	5.0	7
240	5.0	[illegible]
171	5.0	[illegible]
210	6.0	9
213	4.0	6
216B	6.0	9

burning period depends on the tube and on its condition. It is first burned for a period of 30 minutes. Then a test is made of its filament emission. If the emission current is less than the minimum current given in the attached table for the tube in question, the filament is burned for another period of 30 minutes and another emission test is made. It may require a total of 1.5 hours for complete reactivation, or the first period of 30 minutes may be sufficient. If no improvement in the emission current is shown after a few thirty-minute periods of burning, the tube can be considered dead.

If the burning was done without first flashing the tube and no improvement is shown with the continued burning, the filament should be flashed before abandoning hope of reactivation.

Emission Test

During the emission test the tube is operated as a rectifier, the grid and the plate being tied together. The rectifier 213 has two filaments which may be in different conditions. Therefore

Right or

[Herewith are ten questions. They are propounded from articles published in last week's issue, August 31st. If you read that issue carefully, then you should be able to answer all ten questions accurately. Read this week's issue from cover to cover and you will know the answers to next week's questions even before the questions ar put.—Editor.]

* * *

(1).—When a screen grid tube is operated in a resistance coupled circuit, the applied plate voltage should be increased to offset the voltage drop in the coupling resistor and the screen voltage should be decreased.

(2).—An electrolytic condenser of large capacity should be connected across the output of a rectifier next to the tube for best results.

(3).—A screen grid tube in an amplifier is of no advantage because only a small fraction of the amplification factor can be utilized.

(4).—If a high mu tube has a low internal plate resistance it is feasible to couple it to the next tube by means of a transformer.

(5).—If a family of plate current, plate voltage curves is available for a power tube it is possible to calculate the amount of second harmonic distortion which will result when a given signal is impressed on the tube.

(6).—The grid bias on a tube can be determined by measuring the plate current in the tube with a known voltage on the plate.

(7).—In a screen grid tube the plate current flows in the same direction for all plate voltages just as in a three-element tube.

(8).—In a screen grid tube the screen current remains constant and is always less than the plate current.

(9).—Grid current never flows in a tube when the grid is negative with respect to the filament of the cathode.

(10).—When a vacuum tube is used as a grid bias detector for large signals the detected signal is substantially proportional to the radio frequency signal and not proportional to the square of the carrier amplitude.

HORIATED FILAMENTS

Lost Emission—Over-Heating Also Used

n Quirk

ge— g	Flashing	Plate voltage emission test	Minimum emission current (ma)	Filament Resistance (Ohms)
	12.0	50	6	50
	12.0	50	15	25
	12.0	Test as amplifier		25
	16.0	50	25	20
	16.0	50	25	20
	16.0	50	12	20
	16.0	50	25	20
	16.0	50	50	20
	16.0	100	100	10
	16.0	100	50 (per filament)	2.5
	16.0	125	100	6

each of the filaments should be reactivated and tested indipendently of the other. That is, the tube is tested as if it were two different tubes.

The source of the flashing and burning voltages may be either a battery or a transformer. For flashing a B battery of the required voltage might well be used since the duration of the flash is very short, and hence very few milliampere-hours will be taken from the battery. For burning it is necessary to use storage batteries or a suitable transformer, except that the small dry cell tubes may be burned with dry cells.

Whenever it is possible to use a transformer for flashing and burning this is recommended. Inexpensive toy transformers having the required voltages are available and can be purchased in almost any electrical store. If the voltage taps are not exactly those required for a given operation and a given tube, a rheostat can be inserted in series with the filament or filaments for adjusting the voltage to the required value. Fig. 1 shows the circuit for the flashing operation, using a transformer as the voltage source and Fig. 2 shows the connection

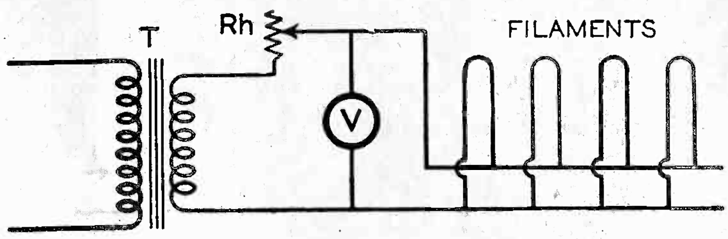

FIG. 2
AN ARRANGEMENT OF CIRCUIT FOR BURNING THE FILAMENT DURING REACTIVATION.

for the burning operation. Essentially the two circuits are the same, differing only in the voltage indicated by the voltmeter across the filament line. Fig. 3 shows the emission test circuit, V being the voltmeter which measures the emission test filament voltage and *ma* the milliammeter which indicates the emission.

To make the process of reactivation clear, let us take a UX-120 tube as an example. The test circuit is arranged as in Fig. 1, with a 25-ohm resistor in place of the filament. Turn on the power and adjust the taps on the transformer and the setting of the rheostat until the reading of the AC voltmeter is 12 volts, the flashing voltage given in the table. Then open the switch, remove the 25-ohm resistor and put the filament of the 120 tube in its place. Get a watch ready for timing the flash. Turn on the power for 10 or 20 seconds. A longer flash will probably vaporize the filament and end the operation.

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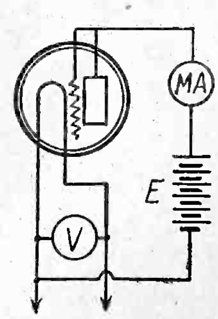

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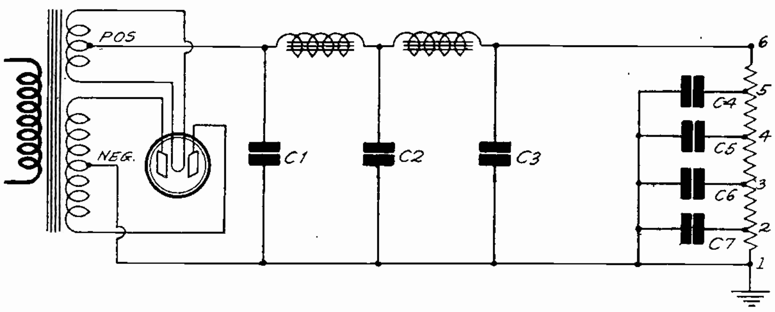

FIG. 782
DIAGRAM OF SIMPLE B SUPPLY.

Summary of HB Compact Advice

PLEASE summarize the mechanical and electrical precautions for the construction of the HB Compact, battery model, described in the August 24th and 31st issues.—H. R.

The precautions are: (1) Mount the coils on the front panel. If Screen Grid Coil Company's models are used no insulation is necessary between the shaft and the front panel, where the steel cabinet is used, but if National Company coils are used, insulation is necessary. If an insulation front panel is used, e.g., hard rubber or bakelite, no other insulation at all is necessary. (2) Put a flexible coupler on the shaft protruding at rear of each coil, and mount the tuning condenser so that its shaft points toward the front panel, but fits into the open side of the flexible coupler or link. (3) Insulate the rheostat if a metal panel is used, otherwise not. (4) If a metal subpanel is used with metal cabinet, use these as grounded A minus, and pick up the A minus lead for circuit connections at the most convenient points from the subpanel, otherwise (as where a baseboard is used), be sure to connect all leads calling for grounded A minus, to the ground binding post, which you start off with as A minus and ground. (5) If the aluminum subpanel is used with steel cabinet, and the socket hardware protrudes downward from bottom a little more than room allows, due to lugs pointing straight down, *bend back the lugs with fingers or pliers,* so they will clear the half-inch space allowed. The lugs are so constructed as to facilitate this bending. (6) Insulate two main condenser brackets and six auxiliary condenser brackets.

* * *

His Radiator a Good Aerial

IN my home I may use the outdoor aerial and radiator ground, or I may ignore the aerial, and connect the radiator lead to the antenna post of the receiver. In either instance I get about the same results in reception. I wonder if it would be all right, therefore, to use the radiator as aerial and dispense with any ground connection.—D. E. R.

Yes. In some locations this condition prevails, due to the ground lead being at a relatively high radio frequency potential. It is a common occurrence in apartment houses, particularly on the upper floors, and in taller buildings.

* * *

Lining Up a Gang Condenser

PLEASE explain an easy way to line up a gang condenser where there is an equalizing condenser across each tuning section of the main condenser.—H. F.

The ear test, or listening test, is one often used. A station is tuned in and the equalizers are adjusted until volume is greatest. Preferably a low wavelength station should be tuned in. The human ear does not appreciate changes in volume unless they exceed 25 per cent., but as wrong adjustment of the equalizers will decrease the volume much more than that, approximately correct adjustment will be possible by the listening test. A better way is to put a 0-25 or similar milliammeter in series with the detector plate lead, just as a precautionary determination of how much plate current is flowing, and then substitute a milliammeter of greater sensitivity, one that reads at a maximum deflection somewhat more than the reading provisionally obtained. This meter should not be more than 0-5 ma. Then the equalizer adjustments may be made on the basis of the detector plate current reading If negative grid bias detection is used, the plate current will increase as the signal increases, while by the leak-condenser method the plate current will decrease as the signal increases. Hence the adjustments are correct when the plate current reads highest by the negative grid bias method and lowest for the leak-condenser method.

* * *

AC Power for 3.3 Volt Tubes

IS it possible to power a receiver using 199 and 120 tubes, omitting batteries at present in service?—G. D.

Yes. Use a 4.5-volt A eliminator, and a 135-volt B eliminator that has suitable intermediate B voltage taps. Usually C batteries serve biasing purposes even in an electrified installation like this one. It is assumed you have AC house lighting supply. Be sure the supply is 110 volts, 50-60 cycles, if the A and B eliminators are designed for such primary voltage and frequency, as nearly all of them are.

* * *

Cure for Motorboating

A RESISTANCE-COUPLED audio amplifier in a receiver that I built motorboats, and therefore I am considering using some factory made radio frequency coils designed for the circuit, instead of home-made coils at present in use.—U. T.

The radio frequency coils have nothing to do with this condition of audio oscillation or audio regeneration called motorboating. Try reducing the values of the plate coupling resistors and grid leaks, particularly the grid leaks. Also use a large capacity, as afforded by Mershon condensers, to bypass the B plus voltages, both intermediate voltages and power tube voltage. These two remedies almost always cure the ill. The only common exception is where the choke coils used in the filter circuit of an AC type B supply have too high a resistance. If yours is an AC circuit, try using only one choke coil, and put a 2 mfd. paper dielectric condenser next to the rectifier, and a large capacity, 18 mfd. or more, even 36 mfd., at the other side of the choke coil.

* * *

Why I^2R Equals the Wattage

I HAVE studied Ohm's law, and understand it so far as it has come under my observation, but I do not understand why the current squared, times the resistance, equals the wattage.—G. H.

It is simply a statement in substituted terms of the definition that the current times the voltage equals the wattage. Thus, as $i \times e$=wattage, by Ohm's law you can substitute for the voltage e, the expression $i \times r$. Hence $i \times e$, representing wattage, becomes $i \times (i \times r)$ or $i^2 r$=wattage. It is customary to use small letters, i, r, e, etc., to designate variable voltages, while capital letters, I, R, E, are used if effective voltages are under discussion.

* * *

A Simple B Supply

PLEASE show a diagram of a simple B supply, using 280 tube, and give data on voltage divider.—F. J. R.

The diagram is published herewith as Fig. 782. A 5-volt winding heats the rectifier tube. The other winding is high voltage, about 350 to 375 volts across each half of the secondary, 700 to 750 across entirety. C1 is 2 mfd., C2 is 2 mfd. or higher capacity, C3 is as high as you can get. The output voltage divider points (1) to (6), may be a 10,000-ohm 50-watt resistor with four sliders, so you can get what voltage values you desire. The by-pass condensers are 2 mfd., except whatever one you use for bypassing the last audio biasing resistor. This capacity should be 4 mfd.

* * *

Use of Different Types of Cabinet

WHERE a metal cabinet is prescribed for a receiver, is it just as well to use a wooden cabinet, with a bakelite front panel, or must one use the steel cabinet?—H. G. S.

The type of cabinet is immaterial. You may use what you have or what you prefer. Where a metal cabinet is prescribed it is usually because of its compactness and physical suitability for the receiver, as well as for economical reasons, since the front panel is a part of the cabinet.

High or Low Ratio for RF?

WHAT ratio do you propose for coupling a tuned primary screen grid circuit to a detector, where the secondary is untuned?—K. H. D.

The ratio must be determined on the basis of the circuit design and this ratio has much to do with the performance. If you want more volume of course use a higher ratio than otherwise, say 1-to-1½ tuned primary to untuned secondary, with close coupling. For greater selectivity a stepdown ratio may be used or looser coupling. The capabilities of the screen grid tube are best proved by a tuned primary, with step-up ratio to the next stage, and the circuit design should be good enough to enable this to be done, even where few tubes are used. In multi-tube circuits, of course, the overall gain is so great that individual stage gain need not be so high. See the HB Compact for battery operation, described in this issue, as an example of a high-gain circuit of the type that interests you.

* * *

Interested in HB Compact

MY attention was attracted to the HB compact as a four tube receiver design for battery operation that promises to excel. I therefore ask you kindly to inform me where I can get a template of the layout of parts or, preferably, a blueprint. I should like to build this tempting receiver at once.—E. W. S.

See the pictorial wiring diagram, published full size, on pages 12 and 13 of last week's issue. Also read the second instalment of the constructional article, published on pages 12 and 13 of that issue. You will not need a blueprint, of course, as the pictorial diagram is, so to speak, a "blueprint printed in black.

* * *

Coil Efficiency Discussed

PLEASE clear up some points on coils for radio frequency. Is it true that coils with a small field, such as doughnut or toroid coils, are more efficient? What is the most suitable diameter for any coil? Is there any advantage in space winding?—H. S. A.

The subject of coil design can not always be dissociated from the particular circuit in which the coils are to be used, as sometimes a less efficient coil solves problems that arise only if a more efficient coil were used. It is certainly untrue that coils with smaller external fields, like toroids, are more efficient. Indeed, it is exactly true to state that the measure of a coil's efficiency is the extent and strength of its field. The only positive asset a coil has is its field, hence the field is its figure of merit, much more so, by the way, than the mutual conductance is a tube's figure of merit. Toroids require much more wire to attain a given inductance than do solenoids, hence toroids have a higher radio frequency resistance, and this effect is sometimes capitalized to produce stabiltiy. But it is resistance directly in the tuned circuit, so has little to commend it, grid suppressors with more efficient coils being preferable. In general, there is no known type of coil superior to the solenoid. What the diameter should be depends on the number of turns of a given type of wire and insulation, since the axial coil length should be about one-and-a-half times the diameter. But variations from this formula are entirely permissible even small-diameter, long length coils being acceptable, especially in modern circuits where the sensitivity of cascaded RF stages is very high, and the selectivity adequate, due to the number of stages. Space winding reduces the distributed capacity, hence is valuable where circuit constants and design may make it otherwise difficult to cover a given band of frequencies, as the broadcast band, using a small capacity condenser (.00025 mfd.) Another advantage is that space winding, being usually done in grooved forms, makes possible greater uniformity of inductance in quantity production.

* * *

Listens In to Television

ONCE in a while on my short-wave set I pick up television signals. These I recognize by their peculiar grinding sounds, a grind produced as if from some whirling motor. Please let me know what it is I hear.—F. S.

You hear the sounds to which the vision has been converted, plus the sound of the motor driving the scanning disc. This motor sound is extraneous and is a form of interference, although it need not necessarily have any bad effect upon the picture. When a moving object is televised, the image is scanned, and the resultant intermittent and graduated light is impressed on a photo-electric cell. This has the property of producing changes in current values equivalent to changes in light values. These changing current values are amplified and many of them are audible. The changes are impressed on a radio frequency wave, this constituting the act of modulation, and the modulated wave is transmitted in the usual way. At the receiving end a set is tuned to the signal frequency, and the transmission process is reversed, so the image can be seen. That is, the radio wave is tuned in, the carrier eliminated, by detection, the audio component amplified in the AF channel, the output fed into a kino lamp which produces values of light corresponding to the values of current, and these light values a scanning disc picks up. Concentration of this controlled light, through the disc holes to a small screen, completes visibility.

* * *

Voltage Divider for B Supply

I AM in doubt as to what type and wattage of voltage divider to use in my B supply.—G. H.

The problems of output voltages are easily solved by using a resistor with adjustable taps. Then with the aid of a high resistance voltmeter, 1,000 ohms per volt, you can establish the desired voltages by moving the taps and finally tightening the moving part. For ordinary purposes, using a B supply for 245 tube, single-sided output, a 10,000 ohm resistor would be satisfactory, rated at 50 watts. If push-pull is used either the wattage of the entire resistor should be raised, say 50 per cent., or the wattage of the biasing section, through which flows the current of the last audio push-pull tubes, should be 75 watts. It is this section that carries the extra current due to push-pull. The rating, of course, is higher than the actual wattage, but this is as it should be. The resistance of the total voltage divider determines the bleeder current at specified voltage. Hence at 300 volts, with 10,000 ohms total, the bleeder is 30 ma. It is well to have a substantial bleeder like this, to stabilize the output voltages, making them stand up better as more plate current is drawn, due to the extra number or different type of tubes and couplings used.

* * *

Reason for Selectivity Difference

THE short-wave receiver I built, to cover the broadcast band as well, I find enough selectivity on the short wavelengths but not enough selectivity on the higher wavelengths (broadcast spectrum). I am satisfied with the receiver, as it was built primarily for short-wave reception, and the broadcast wave feature is purely incidental, and welcome as that much extra service. But I would like to know the reason for this phenomenon of differentiated selectivity. I use plug-in coils. Two coils for the broadcast band require throwing a switch to increase the tuning capacity by parallel condenser connection.—T. Y.

The reduced selectivity on the broadcast band is due to the reduced ratio of inductance to capacity. For best results the ratio of inductance to capacity should be high. This high ratio is not quite feasible in such a receiver as yours, hence the results on the broadcast band must be accepted as they are, merely fair, while reliance for best work is placed on the receiver when it is functioning on the short waves.

FILMED SOUND TO BE USED BY WORLD CHAIN

The formation of an international sound-film radio program producing and distributing system was announced by Malcolm Strauss, president of the Cinema Vision Corporation, a newly organized company.

Films recording only sound will be made in English and foreign languages to be shipped to broadcasting stations throughout the world, to be used in place of personal entertainers.

Production and shipment films will begin in a few months, said Mr. Strauss. WMCA will be the New York transmitting unit.

Under the plan singers, entertainers and orchestras will perform before a microphone connected to a film recorder. The film used will be of sufficient width to accommodate the sound record only.

Seeks Advertisers

The films exposed in the recorder will be developed and a large number of prints will be made and sent to all the participating stations for simultaneous broadcasting. Programs will be made to order for business houses desirous advertising through the new medium. The use of films will eliminate the necessity of land wires (telephones) for connecting stations on a chain.

The Cinema Vision Corporation's personnel includes Donald Flamm, president of WMCA; Marion Gilliam of WPCH and Herman Halstead, vice-president of Paul Block, Inc.

73 Stations on List

Forty-three stations in this country and thirty abroad are said to be allied with the new system, but the entire list cannot be made public at present.

RADIOPHONE TO IRELAND

Transatlantic telephone service will be extended to Belfast, in Northern Ireland; to Dublin, in the Irish Free State and to the Isle of Man next Monday, the American Telephone and Telegraph Company has announced. The rate for conversation between New York and these points will be $46.50 for the first three minutes and $15.50 for each additional minute. The hours of service will be 6:30 A. M. to 10 P. M. Eastern Daylight Saving Time.

Calls from America to Ireland will be routed through New York to a radio transmitting station of the Bell system, across the Atlantic to a receiving station in Great Britain, and thence by wire to London. From London telephone wires will carry the calls to submarine cables running under the Irish Sea.

Penalty Proposed Over Call Letters

Washington.

Disciplinary action is threatened by the Federal Radio Commission against stations that disobey the regulation requiring the announcement of call letters every fifteen minutes except where a continuity would be interrupted.

Complaints that stations are more lax than ever have reached the Commission in impressive quantity. Some of the letter-writers say that announcers are so saturated with the idea of their own importance that they fail to consider the station or the listeners.

Commissioner Lafount proposed that offending stations have their licenses suspended pending a hearing on complaints of call-letter reticence.

4 TUBE FIRMS IN BIG MERGER

Four independent tube manufacturers have merged and formed a new $10,000,000 corporation, with RCA affiliations. They are Sonatron, Televocal, Marathon and Magnatron, with a combined output of 75,000 to 100,000 tubes daily. Plants are in Hoboken, Union City and Newark, all in New Jersey, and in Chicago. The new entity is the Union Radio Corporation.

The Union concern will be licensed by RCA, General Electric and Westinghouse, and it is said RCA will take the corporation's note for $2,000,000 with an option of cash at maturity or 50,000 shares of stock at $40 a share.

The chairman of the board of directors of the new corporation is Joseph E. Davies, former chairman of the Federal Trade Commission. Lehman Brothers are the bankers.

The daily production capacity of these companies, it is said, is from 75,000 to 100,000 rado tubes, made in five plants located at Chicago, Newark, Hoboken and Union City, N. J. This is said to compare favorably with the tube capacity of the Radio Corporation of America and E. T. Cunningham, Inc. A representative of the new company said that this is just a beginning and that other independent tube manufacturers will be added.

A THOUGHT FOR THE WEEK

A MORE or less erudite editorial writer said in a New York newspaper recently that television is pretty nearly ready for everyday use, ending up his blurb with the assertion that "television is on its way."

It doesn't take great brilliancy to remark: and so is the millennium.

RADIO MUSEUM BEING FORMED; RELICS SOUGHT

Washington.

A movement for the creation of a radio museum embodying the display of historical apparatus from the first transmitter used by Marconi to present-day high-powered equipment, is being sponsored by a group of Government radio officials with representatives of private communications companies.

C. U. Mitman, representing the Smithsonian Institute, declared at a recent informal meeting that the Institution was anxious to obtain a brief historical exhibit of radio and would be glad to participate in any projects to procure the equipment. The Radio Corporation of America, which now has an extensive historical collection, through one of its officials, George Clark, expressed its willingness to participate.

Much Material

A conference was held at which it was agreed that a permanent committee should be formed to assume charge of the collection.

A general discussion of the need for a collection of historical apparatus in radio disclosed that a large amount of material was held by the Navy Department and would have to be disposed of within a short time, and that there was other historical equipment at Navy Yards, at various Army depots, at the Bureau of Standards, and in possession of the Radio Corporation of America. Mr. Mitman pointed out that, according to the law, historical apparatus held by various government departments could not be loaned or given to agencies outside the government unless approved by the Smithsonian Institution.

Smithsonian Institution Interested

He suggested that the Smithsonian Institution was anxious to obtain a brief historical exhibit of radio and would be glad to participate in any projects which had to do with the disposal of this equipment.

Mr. Clark pointed out that the Radio Corporation of America had for the past seven years displayed historical equipment at various radio shows throughout the country and now was anxious to preserve this equipment, and was willing to participate financially in its collection and storage until suitable display space could be obtained in a museum such as the National Museum in Washington, Museum of Peaceful Arts in New York, and any other recognized museums.

Reception Barrier Afflicts West Coast, Says Observer

Chicago.

Cities of the West Coast, including Los Angeles, San Francisco, Portland and Seattle, are isolated from the Middle West and East by an heretofore almost solid wall of resistance to radio reception, in the opinion of Prof. Paul G. Andres, vice-president of the Temple Corporation, in charge of engineering.

The principal need to overcome this isolation is more powerful broadcasting stations to raise the energy level at the point of reception, said Prof. Andres.

Among other causes for this isolation, Prof. Andres said was the close proximity of West Coast radio stations to the centers of population in the various cities. He added:

"This makes it very difficult for radio fans of these communities to tune out other local stations and bring in distant ones. Because the energy of these stations is soaked up by numerous steel buildings, programs received from them in the Middle West and East come in very weak, if at all.

"Refinements in engineering work on receivers would help to step up the weak energy of stations in the West and help make programs audible to listeners far away."

The mineral content of the Rocky Mountains, together with a mysterious fissure in the earth East of the Rockies, probably plays an important part also in this isolation problem, according to Prof. Andres.

He discovered this fissure while riding by plane from Kansas City to Los Angeles. On the ground it would appear to be a deep, sloping ravine. From the air it looks like an abrupt drop into a deep crack in the earth which extends North and South for hundreds of miles.

Alphabetical List of Stations by Call Letters; Location and Frequency

[FROM FEDERAL RADIO COMMISSION LIST REVISED UP TO NOON, AUGUST, 27th.]

Station Location Frequency

WAAF—Chicago, Ill., 920
WAAM—Newark, N. J., 1250
WAAT—Jersey City, N.J., 1070
WAAW—Omaha, Nebr., 660
WABC-WBOQ—N.Y. City, 860
WABI—Bangor, Me., 1200
WABZ—New Orleans, La., 1200
WADC—Akron, O., 1320
WAGM—Royal Oak, Mich., 1310
WAIU—Columbus, O., 640
WAPI—Birmingham, Ala., 1140
WASH—Gd. Rapids, Mich., 1270
WBAK—Harrisburg, Pa., 1430
WBAL—Baltimore, Md., 1060
WBAP—Fort Worth, Tex., 800
WBAW—Nashville, Tenn., 1490
WBAX—Wilkes-Barre, Pa., 1210
WBBC—Brooklyn, N. Y., 1400
WBBL—Richmond, Va., 1370
WBBM-WJBT—Chicago, Ill., 770
WBBR—Rossville, N. Y., 1300
WBBY—Charleston, S. C., 1200
WBBZ—Ponca City, Okla., 1200
WBCM—Bay City, Mich., 1410
WBIS—See WNAC
WBMS—Fort, Lee., N. J., 1450
WBNY—New York, N. Y., 1350
WBOQ—See WABC
WBOW—Terre Haute, Ind., 1310
WBRC—Birmingham, Ala., 930
WBRE—Wilkes-Barre, Pa., 1310
WBRL—Tilton, N. H., 1430
WBSO—Wellesley H., Mass., 780
WBT—Charlotte, N. C., 1080
WBZ—Springfield, Mass., 990
WBZA—Boston, Mass., 990
WCAC—Storrs, Conn., 600
WCAD—Canton, N. Y., 1220
WCAE—Pittsburgh, Pa., 1220
WCAH—Columbus, Ohio, 1430
WCAJ—Lincoln, Nebr., 590
WCAL—Northfield, Minn., 1250
WCAM—Camden, N. J., 1280
WCAO—Baltimore, Md., 600
WCAP—Asbury Pk., N. J., 1280
WCAT—Rapid City, N.D., 1200
WCAU—Philadelphia, Pa., 1170
WCAZ—Carthage, Ill., 1070
WCBA—Allentown, Pa., 1440
WCBD—Zion, Ill., 1080
WCBM—Baltimore, Md., 1370
WCBS—Springfield, Ill., 1210
WCCO—Minneapolis, Minn., 810
WCDA—Cliffside, Pk., N.J., 1350
WCFL—Chicago, Ill., 970
WCGU—Coney Island, N.Y., 1400
WCKY—Covington, Ky., 1480
WCLB—Lg. Beach, N.Y., 1500
WCLO—Kenosha, Wis., 1200
WCLS—Joliet, Ill., 1310
WCMA—Culver, Ind., 1400
WCOA—Pensacola, Fla., 1120
WCOC—Columbus, Miss., 880
WCOH—Yonkers, N.Y., 1210
WCRW—Chicago, Ill., 1210
WCSH—Portland, Maine, 940
WCSO—Springfield, O., 1380
WDAE—Tampa, Fla., 620
WDAF—Kansas City, Mo., 610
WDAG—Amarillo, Tex., 1410
WDAH—El Paso, Tex., 1310
WDAY—W. Fargo, N. D., 1280
WDBJ—Roanoke, Va., 930
WDBO—Orlando, Fla., 620
WDEL—Wilmington, Ind., 1120
WDGY—Minneapolis, Minn., 1180
WDOD—Chattanooga, Tenn., 1280
WDRC—New Haven, Conn., 1330
WDSU—New Orleans, La., 1270
WDWF_WLSI—Cr'nst'n, R.I. 1210
WDZ—Tuscola, Ill., 1070
WEAF—New York, N.Y., 660
WEAI—Ithaca, N. Y., 1270
WEAN—Providence, R.I., 550
WEAO—Columbus, O., 550
WEAR—Cleveland, O., 1070
WEBC—Duluth, Minn., 1280
WEBE—Cambridge, O., 1210
WEBQ—Harrisburg, Ill., 1210
WEBR—Buffalo, N. Y., 1310
WEBW—Beloit, Wis., 600
WEDC—Chicago, Ill., 1210
WEDH—Erie, Pa., 1420
WEEI—Weymouth, Mass., 590
WEHS—Evanston, Ill., 1310
WELK—Phila, Pa., 1370
WEMC—Berrien Spgs., Mch. 590
WENR-WBCN—Chicago, Ill., 870
WEPS—Gloucester, Mass., 1200
WEVD—New York, N. Y., 1300
WEW—St. Louis, Mo., 760
WFAA—Dallas, Texas, 1040
WFAN—Philadelphia, Pa., 610
WFBC—Knoxville, Tenn., 1200
WFBG—Altoona, Pa., 1310
WFBJ—Collegeville, Minn., 1370
WFBL—Syracuse, N. Y., 900
WFBM—Indianapolis, Ind., 1230
WFBR—Baltimore, Md., 1270
WFDF—Flint, Mich., 1310
WFI—Philadelphia, Pa., 560
WFIW—Hopkinsville, Ky., 940
WFJC—Akron, O., 1450
WFKD—Philadelphia, Pa., 1310
WFLA-WSUN—Clrw'tr Fla, 900
WGAL—Lancaster, Pa., 1310
WGBB—Freeport, N. Y., 1210
WGBC—Memphis, Tenn., 1430
WGBF—Evansville, Ind., 630
WGBI—Scranton, Pa., 880
WGBS—New York City, 1180
WGCM—Gulfport, Miss., 1210
WGCP—Newark, N. J., 1250

WGES—Chicago, Ill., 1360
WGH—Newport News, Va., 1310
WGHP—Detroit, Mich., 1240
WGL—Ft. Wayne, Ind., 1370
WGMS—See WLB-WGMS
WGN_WLIB—Elgin, Ill., 720
WGR—Buffalo, N. Y., 550
WGST—Atlanta, Ga., 890
WGY—Schenectady, N. Y., 790
WHA—Madison, Wis., 940
WHAD—Milwaukee, Wis., 1120
WHAM—Rochester, N. Y., 1150
WHAP—N. Y. City, 1300
WHAS—Louisville, Ky., 820
WHAZ—Troy, N. Y., 1300
WHB—Kansas City, Mo., 950
WHBC—Canton, Ohio, 1200
WHBD—Bellefontaine, O., 1370
WHBF—Rock Island, Ill., 1210
WHBL—Sheboygan, Wis., 1410
WHBP—Johnstown, Pa., 1310
WHBQ—Memphis, Tenn., 1370
WHBU—Anderson, Ind., 1210
WHBW—Philadelphia, Pa., 1500
WHBY—W. De Pere, Wis., 1200
WHDF—Calumet, Mich., 1370
WHDH—Gloucester, Mass., 830
WHDI—Minneapolis, Minn. 1180
WHDL—Tupper Lake, N.Y., 1420
WHEC-WABO-Roch'st'r, NY. 1440
WHFC—Cicero, Ill., 1310
WHIS—Bluefield, W. Va., 1420
WHK—Cleveland, Ohio, 1390
WHN—New York, N.Y., 1010
WHO—Des Moines, Ia., 1000
WHP—Harrisburg, Pa., 1430
WIAS—Ottumwa, Iowa, 1420
WIBA—Madison, Wis., 1210
WIBG—Elkins, Park, Pa., 930
WIBM—Jackson, Mich., 1370
WIBO—Chicago, Ill., 570
WIBR—Steubenville, O., 1420
WIBS—Elizabeth, N. J., 1450
WIBU—Poynette, Wis., 1310
WIBW—Topeka, Kan., 1300
WIBX—Utica, N. Y., 1200
WICC—Bridgeport, Conn., 1190
WIL—St. Louis, Mo., 1200
WILL—Urbana, Ill., 890
WILM—Wilmington, Del., 1420
WINR—Bay Shore, N. Y., 1210
WIOD—Miami Beach, Fla., 560
WIP—Philadelphia, Pa., 610
WISN—Milwaukee, Wis., 1120
WJAD—Waco, Texas, 1240
WJAG—Norfolk, Nebr., 1060
WJAK—Kokomo, Ind., 1310
WJAR—Providence, R.I., 890
WJAS—Pittsburgh, Pa., 1290
WJAX—Jacksonville, Fla., 1260
WJAY—Cleveland, Ohio, 620
WJAZ—Chicago, Ill., 1480
WJBC—La Salle, Ill., 1200
WJBI—Red Bank, N. J., 1210
WJBK—Ypsilanti, Mich., 1370
WJBL—Decatur, Ill., 1200
WJBO—New Orleans, La., 1370
WJBU—Lewisburg, Pa., 1210
WJBW—New Orleans, La., 1200
WJBY—Gadsden, Ala., 1210
WJDW—Emory, Va., 1370
WJDX—Jackson, Miss., 1270
WJDZ—W. Salem, N. C., 1310
WJJD—Mooseheart, Ill., 1130
WJKS—Gary, Ind., 1360
WJR—Detroit, Mich., 750
WJSV—Mt. Vernon Hills, Va., 1460
WJW—Mansfield, O., 1210
WJZ—New York, N. Y., 760
WKAQ—San Juan, P. R., 890
WKAR—E. Lansing, Mich., 1040
WKAV—Laconia, N. H., 1310
WKBB—Joliet, Ill., 1310
WKBC—Birmingham, Ala., 1310
WKBF—Indianapolis, Ind., 1400
WKBH—La Crosse, Wis., 1380
WKBI—Chicago, Ill., 1310
WKBN—Youngstown, O., 570
WKBO—Jersey City, N.J., 1450
WKBP—Battle Creek, Mch., 1420
WKBQ—New York, N. Y., 1350
WKBS—Galesburg, Ill., 1310
WKBV—Brookville, Ind., 1500
WKBW—Buffalo, N. Y., 1470
WKBZ—Ludington, Mich., 1500
WKEN—Buffalo, N. Y., 1040
WKJC—Lancaster, Pa., 1200
WKRC—Cincinnati, O., 550
WKY—Okla. City, Okla., 900
WLAC—Nashville, Tenn., 1490
WLAP—Louisville, Ky., 1200
WLB-WGMS—Minneapolis, 1250
WLBC—Muncie, Ind., 1310
WLBF—Kansas City, Mo., 1420
WLBG—Ettrick, Va., 1200
WLBL—Stevens Pt., Wis., 900
WLBW—Oil City, Pa., 1260
WLBX—L. I. City, N.Y., 1500
WLBZ—Bangor, Maine, 620
WLCI—Ithaca, N. Y., 1210
WLEX—Lexington, Mass., 1360
WLEY—Lexington, Mass., 1420
WLIB-WGN—See WGN-WLIB
WLIT—Philadelphia, Pa., 560
WLOE—Chelsea, Mass., 1500
WLS—Chicago, Ill., 870
WLSI-WDWF—See WDWF
WLTH—Brooklyn, N. Y., 1400
WLW—Mason, Ohio, 700
WLWL—New York, N. Y., 1100
WMAC—Cazenovia, N. Y., 570
WMAF—Dartmouth, Mass., 1360
WMAK—Buffalo, N. Y., 900

WMAL—Washington, D.C., 630
WMAN—Columbus, Ohio, 1210
WMAQ—Chicago, Ill., 670
WMAZ—Macon, Ga., 890
WMBA—Newport, R. I., 1500
WMBC—Detroit, Mich, 1420
WMBD—Peoria Hts., Ill., 1440
WMBG—Richmond, Va., 1210
WMBH—Joplin, Mo., 1420
WMBI—Addison, Ill., 1080
WMBJ—Pittsburgh, Pa., 1500
WMBL—Lakeland, Fla., 1310
WMBO—Auburn, N. Y., 1370
WMBQ—Brooklyn, N. Y., 1500
WMBR—Tampa, Fla., 1210
WMC—Memphis, Tenn., 570
WMCA—New York, N.Y., 570
WMES—Boston, Mass., 1500
WMMN—Fairmont, W. Va., 890
WMPC—Lapeer, Mich., 1500
WMRJ—Jamaica, N. Y., 1420
WMSG—New York, N. Y., 1350
WMT—Waterloo, Iowa, 1200
WNAC-WBIS—Boston, 1230
WNAD—Norman, Okla., 1010
WNAT—Philadelphia, Pa., 1310
WNAX—Yankton, S. D., 570
WNBF—Binghamton, N.Y., 1500
WNBH—N'w Bedf'rd, Mass., 1310
WNBJ—Knoxville, Tenn., 1310
WNBO—Washington, Pa., 1200
WNBR—Memphis, Tenn., 1430
WNBW—Carbondale, Pa., 1200
WNBX—Springfield, Vt., 1200
WNBZ—Saranac Lk., N.Y. 1290
WNJ—Newark, N. J., 1450
WNOX—Knoxville, Tenn., 560
WNRC—Greensboro, N.C., 1440
WNYC—New York, N.Y., 570
WOAI—San Antonio, Tex., 1190
WOAN—Lawrenceburg, Tenn. 600
WOAX—Trenton, N. J., 1280
WOBT—Union City, Tenn., 1310
WOBU—Charlestown, W.Va., 580
WOC—Davenport, Ia., 1000
WOCL—Jamestown, N. Y., 1210
WODA—Paterson, N. J., 1250
WOI—Ames, Iowa, 560
WOK-WMBB—See WMBB
WOKO—Poughkeepsie, NY., 1440
WOL—Washington, D.C., 1310
WOMT—Manitowoc, Wis., 1210
WOOD—Gd. Rapids, Mich., 1270
WOQ—Kansas City, Mo., 610
WOR—Newark, N. J., 710
WORC—Auburn, Mass., 1200
WORD—Chicago, Ill., 1480
WOS—Jefferson City, Mo., 630
WOV—New York, N.Y., 1130
WOW—Omaha, Nebr., 590
WOWO—Ft. Wayne, Ind., 1160
WPAP-WQAO—See WQAO
WPAW—Pawtucket, R.I., 1210
WPCC—Chicago, Ill., 570
WPCH—New York, N.Y., 810
WPEN—Philadelphia, 1500
WPG—Atlantic City, N.J., 1100
WPOE—Patchogue, N. Y., 1420
WPOR-WTAR—See WTAR
WPRC—Harrisburg, Pa., 1200
WPSC—State College, Pa., 1230
WPTF—Raleigh, N. C., 680
WQAM—Miami, Fla., 1240
WQAN—Scranton, Pa., 880
WQAO-WPAP—N.Y.C., 1010
WQBC—Utica, Miss., 1360
WQBZ—Weirton, W.V., 1420
WRAF—LaPorte, Ind., 1200
WRAK—Erie, Pa., 1370
WRAW—Reading, Pa., 1310
WRAX—Philadelphia, Pa., 1020
WRBC—Valparaiso, Ind., 1240
WRBI—Tifton, Ga., 1310
WRBJ—Hattiesburg, Miss., 1500
WRBL—Columbus, Ga., 1200
WRBQ—Greenville, Miss., 1210
WRBT—Wilmington, N. C., 1370
WRBU—Gastonia, N.C., 1210
WRC—Washington, D. C., 950
WREC—Memphis, Tenn., 600
WREN—Lawrence, Kans., 1220
WRHM—Friedley, Minn., 1250
WRJN—Racine, Wis. 1370
WRK—Hamilton, Ohio, 1310
WRNY—New York, N.Y., 1010
WRR—Dallas, Tex., 1280
WRUF—Gainesville, Fla., 1470
WRVA—Richmond, Va., 1110
WSAI—Cincinnati, O., 1330
WSAJ—Grove City, Pa., 1310
WSAN—Allentown, Pa., 1440
WSAR—Fall River, Mass., 1450
WSAZ—Huntington, W.V., 580
WSB—Atlanta, Ga., 740
WSBC—Chicago, 1210
WSBT—South Bend, Ind., 1230
WSDA-WSGH—See WSGH
WSGH-WSDA—Bklyn., NY. 1400
WSGP—Savannah, Ga., 1410
WSIX—Springfield, Tenn., 1210
WSM—Nashville, Tenn., 650
WSMB—New Orleans, La., 1320
WSMK—Dayton, Ohio, 570
WSOA—Deerfield, Ill., 1480
WSPD—Toledo, Ohio, 1340
WSSH—Boston, Mass., 1420
WSUI—Iowa City, Ia., 580
WSUN-WFLA—See WFLA
WSVS—Buffalo, N. Y., 1370
WSYR—Syracuse, N. Y., 570
WTAD—Quincy, Ill., 1440
WTAG—Worcester, Mass., 580
WTAM—Cleveland, O., 1070

WTAQ—Eau Claire, Wis., 1330
WTAR-WPOR—Norf'lk, Va., 780
WTAW—College Station, 1120
WTAX—Streator, Ill., 1210
WTBO—Cumberland, Md., 1420
WTFI—Toccoa, Ga., 1450
WTIC—Avon, Ct., 600, 1060
WTMJ—Milwaukee, Wis., 620
WWAE—Hammond, Ind., 1200
WWJ—Detroit, Mich., 920
WWL—New Orleans, La., 850
WWNC—Asheville, N. C., 570
WWRL—Woodside, N.Y., 1500
WWVA—Wheeling, W.Va., 1160
KCRC—Enid, Okla., 1370
KDB—Santa Barbara, Cal., 1500
KDKA—Pittsburgh, Pa., 980
KDLR—Devils Lake, N.D., 1210
KDYL—Salt Lake, Utah, 1290
KEJK—Beverly Hills, Calif., 1170
KELW—Burbank, Calif., 780
KEX—Portland, Ore., 1180
KFAB—Lincoln, Nebr., 770
KFAD—Phoenix, Ariz., 620
KFBB—Great Falls, Mont., 1360
KFBK—Sacramento, Calif., 1310
KFBL—Everett, Wash., 1370
KFDM—Beaumont, Tex., 560
KFDY—Brookings, S.Dak., 550
KFEL—Denver, Colo., 940
KFEQ—St. Joseph, Mo., 560
KFGQ—Boone, Iowa, 1310
KFH—Wichita, Kans., 1300
KFHA—Gunnison, Colo., 1200
KFI—Los Angeles, Calif., 640
KFIF—Portland, Ore., 1420
KFIO—Spokane, Wash., 1230
KFIZ—Fond du Lac, Wis., 1420
KFJB—Marshalltown, Ia., 1200
KFJF—Okla., City., Okla., 1470
KFJI—Astoria, Ore., 1370
KFJM—Gd. Forks., N.D., 1370
KFJR—Portland, Ore., 1300
KFJY—Fort Dodge, Iowa, 1310
KFJZ—Fort Worth, Tex., 1370
KFKA—Greeley, Colo., 880
KFKB—Milford, Kans., 1050
KFKU—Lawrence, Kans., 1220
KFKX-KYW—See KYW
KFKZ—Kirksville, Mo., 1200
KFLV—Rockford, Ill., 1410
KFLX—Galveston, Tex., 1370
KFMX—Northfield, Minn., 1250
KFNF—Shenandoah, Iowa, 890
KFOR—Lincoln, Nebr., 1210
KFOX—Long Beach, Calif, 1250
KFPL—Dublin, Tex., 1310
KFPM—Greenville, Tex., 1310
KFPW—Siloam Spgs., Ark., 1340
KFPY—Spokane, Wash., 1390
KFQA-KMOX—See KMOX
KFQD—Anchorage, Alaska, 1230
KFQU—Holy City, Calif., 1420
KFQW—Seattle, Wash., 1420
KFQZ—Hollywood, Calif., 860
KFRC—San Francisco, Cal., 610
KFRU—Columbia, Mo., 630
KFSD—San Diego, Calif., 600
KFSG—Los Angeles, Calif., 1120
KFUL—Galveston, Tex., 1290
KFUM—Colo. Springs, Col., 1270
KFUO—Clayton, Mo., 550
KFUP—Denver, Colo., 1310
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60, 62, 20, 64, 30 105, 51, 16, 32, 50, 25 A.C., 28 A.C., 41, Receptor S.P.U., 17, 18, 33.

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Type F series filament, type E series filament, type D series filament, Model K, Model H.

ATWATER-KENT
10B, 12, 20, 30, 35, 48, 32, 33, 49, 38, 36, 37, 40 42, 52, 50, 44, 43, 41 power units for 37, 38, 44, 43, 41.

CROSLEY
XJ, Trirdyn 3R3, 601, 401, 401A, 608, 704, B and C supply for 704, 704A, 704B, 705, 706.

ZENITH
39, 39A, 392, 392A, 40A, 35PX, 35APX, 352PX, 352APX, 37A, 35P, 35AP, 352P, 352AP, 34P, 342P, 33, 34, 35, 35A, 342, 352, 352A, 362, 31, 32, 333, 353A, power supply ZE17, power supply ZE12.

MAJESTIC
70, 70B, 180, power pack 7BP3, 7P6, 7P3 (old wiring) 8P3, 8P6, 7BP6.

FRESHMAN
Masterpiece, equaphase, G, G-60-S power supply, L and LS, Q15, K, K-60-S power supply.

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FREED-EISEMANN
NR5, FE18, NR70, 470, N R 5 7, 457, NR11, NR80 DC.

STEWART-WARNER
300, 305, 310, 315, 320, 325, 500, 520, 525, 700, 705, 710, 715, 720, 530, 535, 750, 801, 802, 806.

GREBE
MU1, MU2, synchrophase 5, synchrophase A C 6, synchrophase AC7, Deluxe 428.

PHILCO
Philco-electric, 82, 86.

KOLSTER
4-tube chassis used in 6 tube sets, tuning chassis for 7 tube sets, power amplifier, 7 tube power pack and amplifier, 6 tube power pack and amplifier, rectifier unit K23.

STROMBERG-CARLSON
1A, 2B, 501, 502, 523, 524, 635, 636, 403AA power plant, 404 RA power plant.

ALL-AMERICAN
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COLONIAL
26, 31 A.C., 31 D.C.

WORKRITE
8 tube chassis, 6 tube chassis.

AMRAD
70, 7100, 7191 power unit.

SPARTON
A.C. 89.

MISCELLANEOUS
DeForest F5, D10, D17, Super Zenith Magnavox dial, Thermyodyne, Grimes 4DL inverse duplex, Garod neutrodyne, Garod EA, Ware 7 tube, Ware type T, Federal 102 special, Federal 59, Kennedy 220, Operadio portable, Sleeper RX1, Armad inductrel.

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TROUBLE SHOOTING IN "B" BATTERY ELIMINATORS
SPEAKERS AND TYPES
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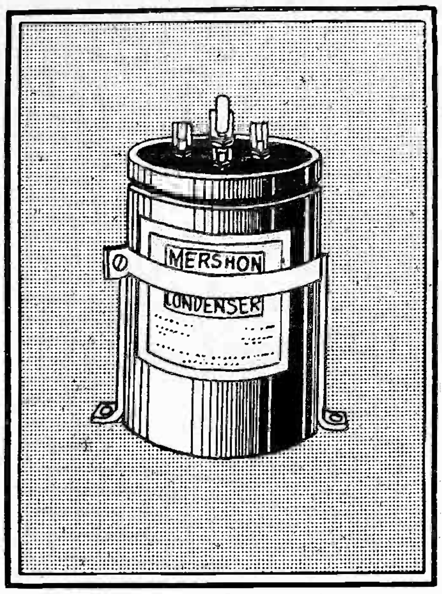

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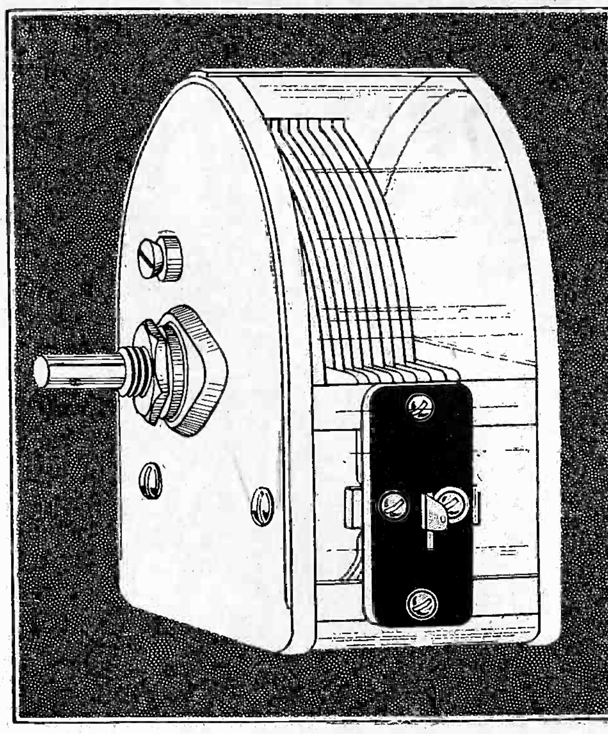

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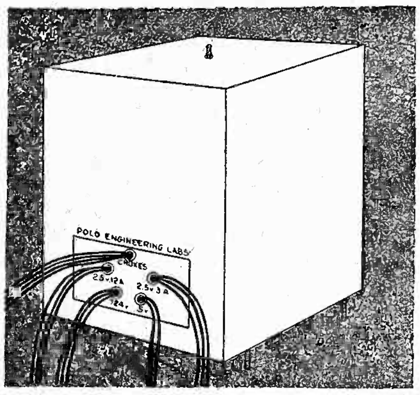

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To do your radio work properly you need meters. Here is your opportunity to get them at no extra cost. See the list of nine meters at left. Heretofore we have offered the choice of any one of these meters free with an 8-weeks subscription for RADIO WORLD, at $1, the regular price for such subscription. Now we extend this offer. For the first time you are permitted to obtain any one or more or all of these meters free, by sending in $1 for 8-week's subscription, entitling you to one meter; $2 for 16 weeks, entitling you to two meters; $3 for 26 weeks, entitling you to three meters; $4 for 35 weeks, entitling you to four meters; $5 for 44 weeks, entitling you to 5 meters; $6 for 52 weeks, entitling you to six meters. Return this offer with remittance, and check off desired meters in squares at left.

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High Resistance Meter

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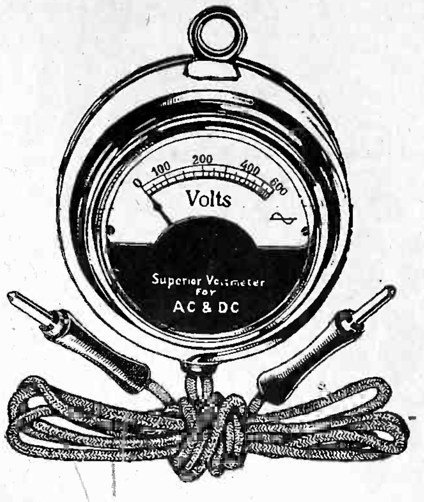

O-600 AC and DC Voltmeter—same meter reads both—with 32" long flexible cords built in, and equipped with hanger. Extreme diameter (less hanger) 2¾".

MOST USEFUL!

Here is a meter that serves an abundance of uses, because it has a wide voltage range, 0 to 600 volts, and measures voltage of alternating current and direct current, and is accurate to 1%. In a meter it's accuracy that counts.

You can measure not only the DC voltages of B eliminators, power packs and B batteries with easily legible readings of 20 volts per division of the scale, with wide divisions between 100 and 400 volts, so that you can easily see to within 5 volts, but you can also measure the AC voltage across high-voltage power transformer secondaries. If full-wave rectification is used, you measure each of the two sections of the transformer secondary and add the voltages. Thus up to 1,200 total volts across the secondary may be read. For half-wave rectification, a secondary up to 600 volts is read across the total winding. You find out at once whether this winding is open or shorted, since no reading then would be obtained, or find out whether the voltage is right, or too high or too low. In all instances the AC voltage across the secondary should read higher than the desired DC output, due to the voltage drop in the tube and to the current in the entire voltage divider and its sections. The normal deduction from the AC voltage, to obtain the DC voltage, is at least 10%.

A REQUISITE FOR SERVICING!

Often service men, experimenters and students must know not only the transformer high voltage, but also whether the AC line voltage is the rated 110 volts or not. This meter tells you. Connect it across the 110-volt line. By reading this voltage and the voltage of the high-voltage secondary you can also determine the step-up ratio, by dividing the smaller reading into the larger.

Because this is a high-resistance meter you can rely on the accuracy of the readings.

Only a high-resistance meter can accurately measure the DC voltage of a B eliminator. Other meters draw so much current that the reading may be 50 volts less than what it should be, or still more inaccurate, and you could almost guess the voltage more accurately than a low-resistance meter would read.

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This meter is sold on a 5-day money-back guaranty. Buy one, try it, test it thoroughly, compare it with other meters in performance and appearance. If not fully satisfied, send it back and your money will be promptly refunded.

The meter is full nickel plated, highest possible polish, has green cords, with red (positive) and black (negative) moulded bakelite tip-holders, and sturdy tips. The positive and negative indications are for DC measurements. For AC the meter may be connected at random.

This meter, which is of the moving vane type, is made in Germany and represents finest workmanship.

Cat. M600 AC-DC $6.00

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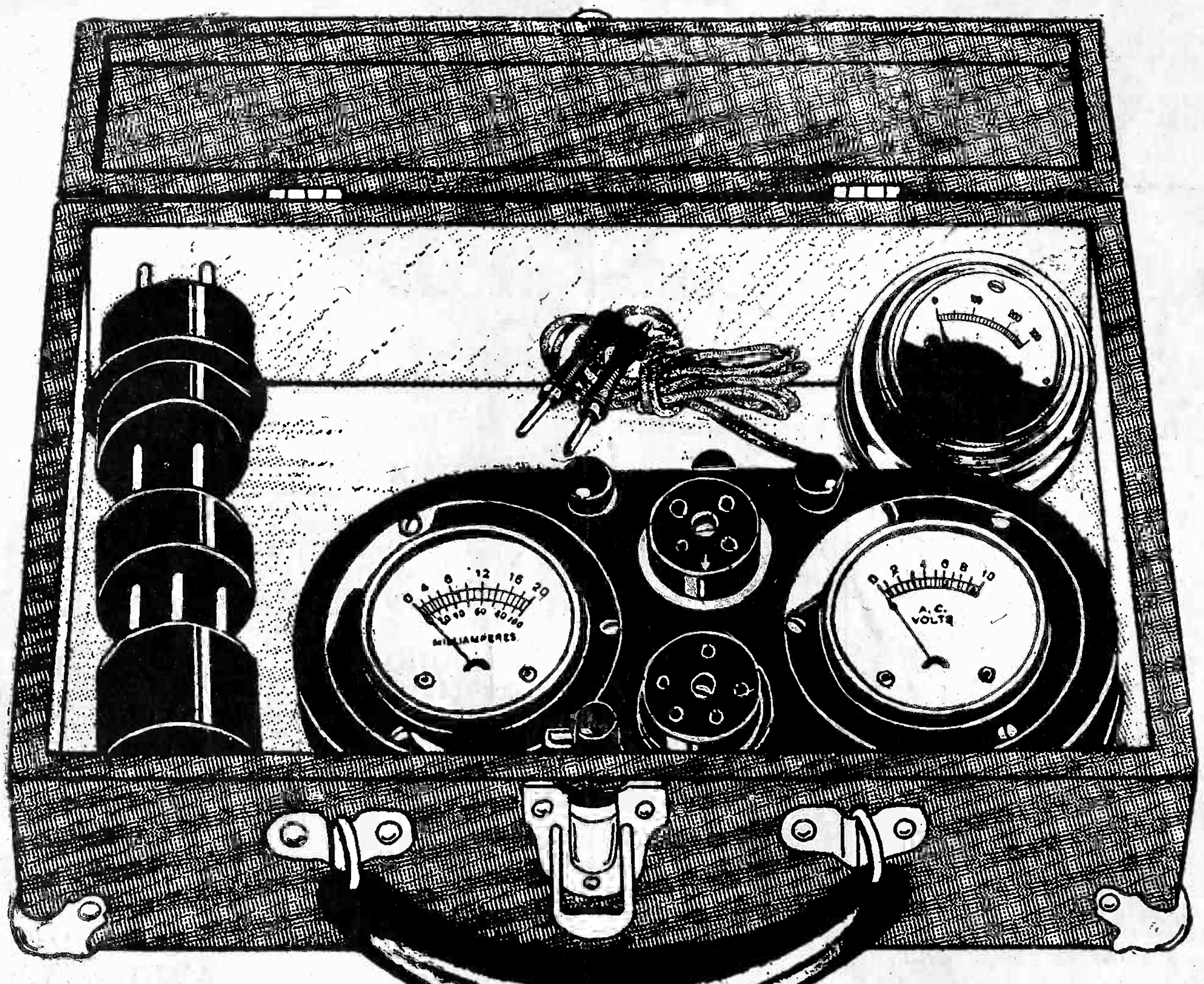
This combination of meters tests all standard tubes, including the new AC screen grid tubes and the new 245 tube, making thirteen tests in 4½ minutes ! Instruction sheet gives these tests in detail.



A PORTABLE testing laboratory is yours when you possess a combination Jiffy Tester, for then you can measure the filament and plate voltages of all standard tubes, including AC tubes, and all standard battery-operated or AC screen grid tubes; also plate voltages up to 500 volts on a high resistance meter that is 99% accurate; also plate current.

The Jiffy Tester consists of a 0-20, 0-100 milliammeter, with change-over switch and a 0-10 volt AC and DC voltmeter (same meter reads both), with two sockets, one for 5-prong, the other for 4-prong tubes; a grid bias switch and two binding posts to which are attached the cords of the high resistance voltmeter; also built-in cable with 5-prong plug and 4-prong adapter, so that connections in a receiver are transferred to the Tester automatically. Not only can you test tubes, but also opens or shorts in a receiver, continuity, bias, oscillation, etc. The instruction sheet tells all about these tests.

In addition you can test screen grid tubes by connecting a special cable, with clip to control grid (cap of tube) and other end of special cable to the clip in the set that went to the cap before the tube was transferred to the tester.

THE new carrying case, which is furnished FREE with each order for a Combination Jiffy Tester, contains the entire outfit, including the three meters, cable and plug, and three adapters (one for 4-prong tubes, two for 199 tubes). This case is 10½x7¾x3½" and has nickel corner pieces and protective snap-lock. The case is made of strong wood, with black leatherette overlay.

To operate, remove a tube from the receiver, place the cable plug in the vacant receiver socket, put the tube in the proper socket of the Tester, connect the high resistance meter to the two binding posts, and you're all set to make the thirteen vital tests in 4½ minutes!

The Combination Jiffy Tester is just the thing for service men, custom set builders, experimenters, students, teachers and factories. Order "Jiffy 500." The price is only $14.50.

If a 0-600 AC and DC high resistance meter (99% accurate) is desired, so house electricity line voltage and power transformer voltages can be measured, as well as plate voltage, instead of the 0-500 DC voltmeter, order "Jiffy 600" at $15.50.

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(3) One 0-500 volts high resistance voltmeter, 99% accurate; with tipped 30" cord to measure B voltages.
(4) One 5-prong plug with 30" cord for AC detector tubes, etc., and one 4-prong adapter for other tubes.
(5) One grid switch to change bias.
(6) One 5-prong socket.
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(8) Two binding posts.
(9) One handsome moire metal case.
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(12) One screen grid special cable.

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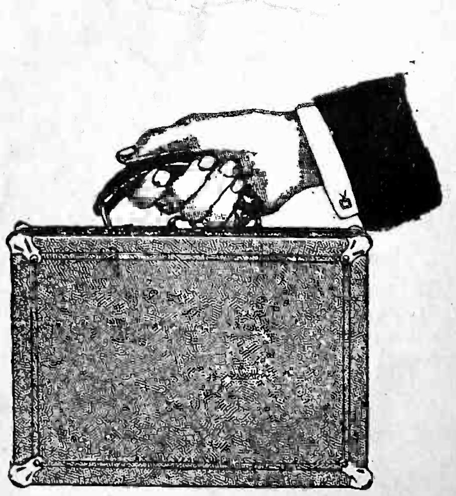

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