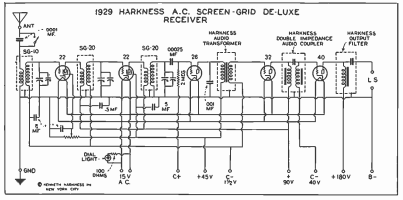
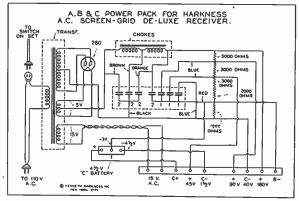
The Harkness 1929 Screen Grid De Luxe Receiver





LIST OF PARTS REQUIRED

Receiver

1—Drilled and Engraved Bakelite front panel, 7" x 21".
1—Drilled and Engraved Bakelite subpanel, 7" x 20".
1—Pair Harkness subpanel brackets.
1—Harkness Type SG-10 R. F. Coil.
2—Harkness Type SG-20 R. F. Coils.
3—Harkness Aluminum Coil Shields.
1—Harkness Type T-500 Audio Transformer.
1—Harkness Double Impedance audio coupler.
1—Harkness audio output filter.
3—U. S. L. .00035 mfd. variable condensers.
3—Hammarlund Equalizers.
1—Hammarlund Drum Dial.
4—Aerovox Type 250, .5 mfd. condensers.
1—Aerovox Type 1450, .0001 mfd. condenser.
1—Aerovox Type 1450, .00025 mfd. condenser.
1—Aerovox Type 1450, .001 mfd. condenser.
1—Aerovox Type 1049 Grid Leak Mounting.
1—Aerovox Type 1092, 2 megohm grid leak.
2—Saturn switches.
1—Centralab 250,000 ohm potentiometer.
5—Eby UX tube sockets.
2—Eby binding posts "ANT" and "GND" respectively.
2—Eby tip jacks.
2—Carter Screen Grid tube connectors.
1—Aerovox Type 980, 100 ohm resistor.
1—Special, 14" condenser shaft, ¼" diameter.
Miscellaneous screws, nuts, lugs, etc.

Power Pack

1—Harkness Type 1580 Power Transformer, with cord and switch receptacle.
1—Silver-Marshall Unichoke.
1—Aerovox Type BC-280 Condenser Block.
1—Aerovox Type 996-171 Tapped Pyrohm resistor.
1—Aerovox Type 992, 1,000 ohm Pyrohm resistor.
1—Aerovox Type VV-1 vertical resistor mounting.
1—Eby UX socket.
1—Drilled Bakelite terminal strip.
1—Cord and plug.
1—Baseboard.
Miscellaneous screws, nuts, lugs, bushings, etc.

THE CIRCUIT

THE new Harkness 1929 Screen Grid De Luxe Receiver is the latest addition to the famous series of radio receivers developed by Kenneth Harkness of "Harkness Reflex," "Counterflex" and "Counterfonic" fame.

This new receiver takes full advantage of the possibilities inherent in the construction of the screen grid tube. The use of two stages of screen grid amplification provides a sensitivity and distance getting ability that cannot be equaled by receivers using three and four stages of the ordinary radio frequency amplification with 201A and 226 type tubes.

The extremely low interelectrode capacity of this new tube makes possible a very high amplification without the usual troubles with oscillation found with the ordinary types of radio frequency amplifier tubes and circuits. No "lossers" or "suppressors," with consequent loss in efficiency, are necessary when these tubes are used in a properly designed circuit. By taking advantage of the full amplifying qualities of the tubes, a receiver is obtained which is so sensitive that it will tune in distant stations with ease right through local stations at any time of the day.

This sensitivity is obtained without the usual critical tuning which results from pushing ordinary tubes right up to the limit just below the oscillating point, and therefore does not affect the quality of reproduction obtained.

The excellent tone quality of this receiver is obtained by means of an audio amplifier consisting of a stage of transformer coupled audio frequency amplification, a stage of double impedance coupled amplification and an output filter which prevents the heavy direct current in the plate circuit of the last stage from flowing through the speaker windings.

The use of the double impedance system in the second stage makes it possible to get an unusually large undistorted output. No distortion is heard, even when much louder volume than will ever be required in the home is brought in.

The receiver and power pack are designed for easy assembly and wiring. While they are made up in two units, they are arranged so as to fit in the same cabinet, thus making a complete, self-contained unit.

Both the receiver and power pack are furnished in kit form with all the miscellaneous parts that are required to build them and with complete blueprints and instructions for building them and placing them in operation.

More detailed information concerning these units can be obtained by writing direct to Mr. Kenneth Harkness, Kenneth Harkness, Inc., 72 Cortlandt Street, New York City, N. Y.

Complete Catalog of Aerovox Products May Be Had Free on Request to
Aerovox Wireless Corporation, 70 Washington Street, Brooklyn, N. Y.

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The AEROVOX Research Worker

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Principles of Voltage Divider Design

PART 5

By the Engineering Department, Aerovox Wireless Corp.

THE discussion of the essential difference between the D. C. tubes, with special reference to the factors to be considered in determining the proper grid bias to use with each type of tube and also the path taken by the current in the plate circuit of a tube brings us to a consideration of the methods to employ to supply the proper grid bias to A.C. tubes.

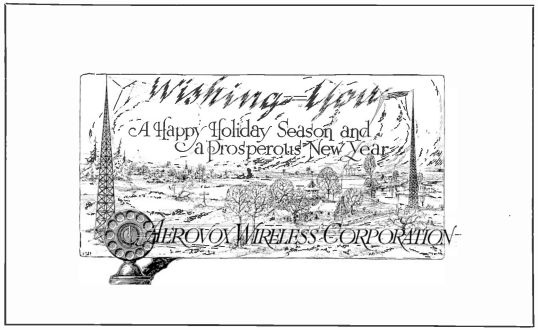
A. C. tubes fall into two distinct classes. In one class of A. C. tubes such as the CX-326, CX-112A, CX-371A, CX-310 and CX-350, the filament of the tubes also acts as the cathode in the same way that the filament acts as a cathode in D. C. tubes. In other words, the filament which carries the current which heats the filament, also furnishes the electrons and serves as the cathode of the tube.

In the second class we have the heater type tubes such as the C-327 tubes in which the filament which carries the heating current is surrounded by a cathode element which emits electrons when heated by the heat produced in the filament. In this case the filament performs only the function of a heater and not of a cathode.

In designing A. C. circuits, it is necessary to keep this difference in mind. More detailed information on the differences between the circuits used with these two types of tubes will be discussed later in this article.

One of the oldest, simplest and most common methods of providing the grid bias for the tubes of a receiver from a power pack makes use of the voltage drop at different points of a voltage divider. A conventional type of voltage divider in which this system is used is shown in Fig. 25. It will be noted that the voltage taps show a total voltage of 180 volts between the "B+ Max." and the "B—" tap and a voltage of 40 volts between the "B—" tap and the "C—40 volt" tap.

In this case, the "B+ 180 volt" tap is the most positive end of the output of the filter while the "C—40



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volt" tap is the most negative end of the output with a total voltage difference between the two extremes of 220 volts.

While this makes a very simple system for getting both "B" and "C" voltages from the voltage divider, it has the disadvantage of coupling the various grid circuits of the receiver through a common coupling resistor.

The system now generally used is that shown in Fig. 26 in which a separate external resistor is used for each stage or group of tubes which require a different value of grid bias.

The grid bias resistors "R1" and "R2" are connected between the negative terminal of the filter output and the cathodes of the tubes.

In both cases, the total output voltage is 220 volts. In the case shown in Fig. 25, the actual voltage applied in the plate circuit of the power tubes is the voltage between the "B—" terminal and the "B+ 180 volt" terminal and this amounts to 180 volts because the "B—" terminal in such a circuit is connected to the cathode of the tube.

In the case shown in Fig. 26 however, the voltage measured between the so-called "B—" terminal and the maximum positive voltage is the full output of the filter and is therefore 220 volts. This voltage however is not applied in the plate circuit because the grid bias voltage, obtained by the flow of current through resistor "R1", which makes point "X" of resistor "R1" positive with respect to the "B—" terminal is deducted from the total output voltage so that the net effect is actually the same as that obtained in Fig. 25, with a plate voltage of

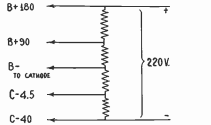

Fig. 25

180 volts applied in the plate circuit of the power tube.

The actual wiring diagram of the power stage of a receiver with its associated connections to the power unit output is shown in Fig. 27, and serves to make the conditions existing in this stage clear. The total voltage across the output of the filter is 220 volts. The positive end of the filter circuit is connected to the plate of the tube through the choke coil "L". The "B—" end of the filter is connected to the cathode through the grid biasing resistor "R2". Since the "B—" terminal of the output is the most negative point of the filter and since the grid bias resistor "R2" is connected in the plate circuit of the tube in the path of the current from the plate of the tube, thence

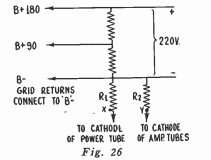

Fig. 26

to the filament (cathode) then through the grid bias resistor, then to the "B—" terminal of the power supply unit and then through the filter and rectifier system back to the "B+" end of the filter system, point "X" of resistor "R2" must necessarily be positive with respect to the "B—" terminal of the filter system. The connection of the "X" end of resistor "R2" to the center-tap of the shunt resistance across the filament of the tube which acts as the cathode, places the filament or cathode at a positive potential with respect to the "B—" terminal of the power unit, or what amounts to the same thing in different words, the "B—" end of the filter system is negative with respect to the cathode of the tube, by an amount which depends on the resistance of resistor "R2" and the current which is flowing through "R2". If the current flowing through the resistor and the value of the resistor is such as to produce a voltage drop of 40 volts in the resistor, so that point "X" is 40 volts positive with respect to point "Y", then a voltmeter will read 220 volts when connected between the "B—" and "B+" terminals of the power supply unit but will read only 180 volts when connected between point "X" of resistor "R2" and the "B+" terminal of the power supply unit.

In actual practice, the connection of the grid return to the "B—" terminal puts a negative grid bias of 40 volts on the grid of the tube, because the "B—" terminal is 40 volts negative with respect to the cathode of the tube.

In the power stage, where the shunt potentiometer connected across the filament winding of the tube has an appreciable resistance, the values recommended for this purpose varying from 50 to 200 ohms, it is necessary to take into consideration the voltage drop due to the resistance of the potentiometer, in causing part of the voltage drop required for the grid bias. The current in the plate circuit divides at the center tap of the potentiometer, half of it flowing through the resistance of one-half of the potentiometer and the other half flowing through the other half of the potentiometer.

For a single CX-371A tube we can take the current flowing in the plate circuit of that tube as 20 milliamperes (.020 amperes), so that 10 milliamperes flows through each half of the potentiometer. If a 100-ohm potentiometer is used, 10 milliamperes flowing through 50 ohms (one leg of the potentiometer) will produce a voltage drop of .5 volts. The grid bias required for a CX-371A when used as an A. C. tube is 43 volts so that the grid bias resistor should be figured to give a voltage drop of 42.5 volts when a 100 ohm potentiometer is used across the filament. If a 200-ohm potentiometer were used, 10 milliamperes would flow through each 100 ohm section, producing a voltage drop of one volt and making it necessary to figure the grid bias resistor to give a voltage drop of only 42 volts.

With the low voltage tubes such as the CX-326 and C-327, the potentiometers used are of lower resistances, ranging from 10 to 30 ohms. The plate current taken by these

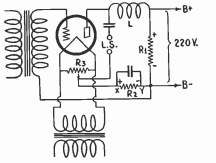

Fig. 27

tubes is also much lower. With a CX-326 tube for instance used with a plate voltage of 135 volts and a current drain of 4 milliamperes, only two milliamperes would flow through each leg of the shunt potentiometer. If a 10-ohm potentiometer is used, this would result in 2 milliamperes flowing through 5 ohms and would produce a voltage drop of only .01 volt, a value so small that it can be neglected in calculating the proper grid bias resistor required to give the necessary grid bias.

If a single shunt potentiometer is used across the filaments of two or more tubes, as is the case when two power tubes are connected in push pull or when two radio frequency or audio frequency amplifier tubes are supplied by the same

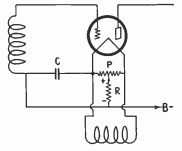

Fig. 28

filament, plate and grid voltages, the plate current flowing through each leg of the potentiometer is equal to one-half of the total plate current of the tubes whose filaments are connected in parallel from the same potentiometer. In the case of two CX-371A tubes in push pull drawing a total of 40 milliamperes, and with a 200-ohm potentiometer across the filaments, the voltage drop produced by the potentiometer resistance resulting from the flow of 20 milliamperes through 100 ohms would be two volts.

There is no hard and fast rule regarding the proper values of shunt potentiometers to use with different tubes but values of 20 ohms for a single CX-326 tube, 40 ohms for a single C-327 tube and 100 ohms for a single CX-112A, CX-371A, CX-310, CX-380 or CX-381 are good average values. Where two or more tubes are used in parallel, the resistance values given above can be divided by the number of tubes used in parallel. For two CX-371A tubes for instance, the shunt potentiometer can be cut down to half the value given or 50 ohms.

We can next take up the difference between the connections used in the two main classes of tubes, one in which the filament acts both as the heater and the cathode such as is the case in the CX-326, CX-112A, CX-371A, CX-310 and CX-350 and the other the class generally referred to as "heater type" tubes in which the filament merely acts as a heater with a separate electrode to serve as the cathode.

The connections used to heat the filament and provide the grid bias for the conventional type of CX-326, CX-112A, CX-371A, CX-310 or CX-350 type tube are shown in Fig. 28. It will be noted that the grid bias resistor "R" is connected between the "B—" lead to the power pack and the center tap of the filament shunt potentiometer "P". The grid return is connected to the "B—" lead, thus putting a negative bias, of a value which depends on the current flowing through "R" and the resistance of "R", on the grid of the tube.

A condenser "C", preferably having a value of 2 mfds. although a value as low as .5 mfd. can be used, should be connected either as shown in Fig. 28 or directly across the grid bias resistor "R" to serve as a bypass across the resistor. The proper method of connecting a heater type tube such as the C-327 as a radio frequency or audio frequency amplifier or for grid bias detection is shown in Fig. 29. In this type of tube the filament serves merely as a heater and not as a cathode. The grid bias resistor "R" is therefore connected between the grid return and the cathode. The grid return is also connected to the "B—" lead, thus putting the negative bias on the grid. The center tap of the potentiometer connected across the filament of the tube can be connected with either the "B—" lead or with the "C— 6 to 10 volts" lead, so as to place the cathode and the filament at widely differing potentials to prevent hum.

The proper connections for using

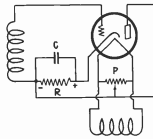

Fig. 29

the C-327 tube as a detector with grid condenser and leak are shown in Fig. 30. In this system the grid biasing systems used for amplification and grid bias detection are not necessary and the grid return is connected directly to the cathode. The center tap of the filament shunt potentiometer should be connected either to the "B—" terminal or to one of the "C—" terminals so as to place a difference of potential between the cathode and the filament to minimize hum.

The calculation of the proper value of resistance to use for the grid bias resistor then resolves itself into the following considerations:

The voltage drop produced by the resistance of the filament shunt potentiometer as already explained in this article should be figured out. This factor is taken into consideration only in the case of CX-112A, CX-371A, CX-310 and

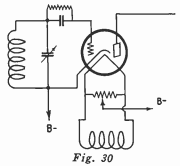

Fig. 30

CX-350 tubes which draw comparatively heavy plate current and use filament shunt potentiometers having fairly high resistance values. This factor can be disregarded entirely in calculating the proper value of grid bias resistor to use with CX-326 and C-327 tubes.

The plate current drain of all the tubes whose grid bias is supplied from the same grid bias resistor should be totaled and used as the current flow factor.

The grid bias voltage required is found by subtracting the voltage drop due to the resistance of the shunt potentiometer from the total grid bias voltage required for the tubes at the plate voltage used. The value of the grid bias resistor can then be found by dividing the voltage drop required by the plate current drain of the tubes which are connected together.

This article completes the series on "Voltage Divider Design".

AEROVOX EXPANDS AGAIN

So great has been the demand for Aerovox products during the past few months that the 10,000 square feet of extra space added to the Aerovox plant last July has proved inadequate to meet the demands for increased production.

In spite of the additional space, the installation of special machinery to speed up production and the use of extra shifts, it has been found necessary to add another 15,000 square feet to the plant.

The Aerovox Wireless Corporation takes this opportunity to again thank its customers whose wholehearted co-operation has made this remarkable expansion possible.